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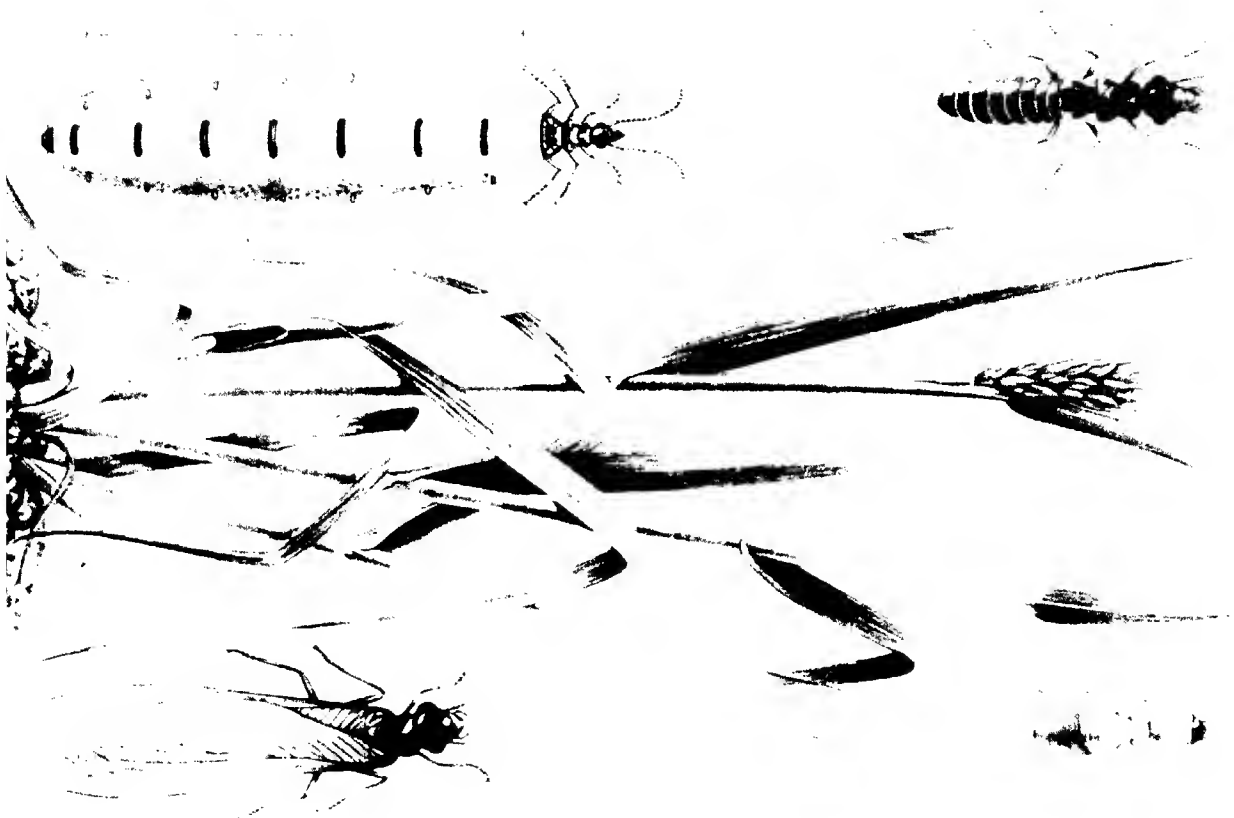


EXPLANATION OF PLATE XXVII.

Termites.

In the centre are seen wheat plants which have been cut through below ground by Termites.

In the right-hand upper corner is a worker, apparently immature: in mature individuals the head is generally yellow.

In the lower right-hand corner is a winged form and in the left-hand upper corner an individual which has shed its wings.

A full grown queen is seen in the lower left-hand corner, the legs are disproportionately large.

The hair line alongside each figure indicates the natural size of the insect shown.

TERMITES OR WHITE ANTS.

By T. BAINBRIGGE FLETCHER, R.N., F.E.S., F.Z.S.,

Entomologist to the Government of Madras.

It is said that a well known Encyclopædia once defined a crab as "a little red fish which swims backwards," on which the obvious criticism is that a crab is not a fish, it does not swim backwards, and that it is red only after it has been boiled. The popular nomenclature of insects often exhibits traces of a similar confusion of ideas: a "Black-beetle," for example, is not always black and never a beetle, and a "White Ant" is not an ant at all and is not necessarily white. It is unfortunate that the term "White Ant" should ever have been applied to these insects more correctly known as "Termites," but the term "White Ants" has taken too strong a hold on the popular imagination to be easily dispossessed.

Termites, to give them the correct name by which they will be referred to hereafter, have usually been classified amongst the Neuroptera, an order which includes very diverse groups of insects, such as Dragonflies, Ant-lions, and Lace-wing flies. Recent research has shown, however, that their affinities are rather with the Orthoptera and that they probably share with Cockroaches the honour of descent from a common primitive stock. It is certain that Termites and Cockroaches have many structural peculiarities in common although to the ordinary observer no two insects appear more dissimilar. On the other hand, except for their social habits and caste system (which is really only the principle of division of labour seen in nearly all animals practising a social existence) Termites have little in common with the true Ants, which belong to the order Hymenoptera (Ants, Bees and Wasps).

In India we are only too well aware of the damage done by Termites to houses and wooden buildings of all sorts and to household furniture. Working in concealment and being careful not to give any external sign of their attack, the mischief is often completed before any suspicion is aroused, and a beam or plank of wood, apparently substantial, is suddenly found to be nothing but a mere empty shell, the whole of whose interior has been eaten away by these tiny white insects which rapidly scuttle away into the obscurity of their galleries when the light is let in upon them. In some cases, when the material attacked is a beam supporting a weight, their operations seem directed by an intelligent appreciation of the stresses borne by the wood and portions are left to bear the strain or the interior is filled up with mud to replace the material removed. Some species, however, which normally live in decaying wood, seem to fill the interior with mud whether subject to stress or not, and perhaps they do this to keep the air moist in their galleries.

The damage done to crops is not so apparent to the casual observer as is that done to buildings, but the latter is really insignificant in comparison with the former. In many parts of India the normal damage to cereals is from one to two annas, rising to three or four annas or even more in bad years. Not only cereals are attacked but valuable crops such as sugarcane, poppy, groundnut, *kharasani*, fruit-trees, castor, jute, peas, sunflower, etc. The annual loss caused by Termites attacking crops in British India alone is estimated at over twenty million pounds sterling. The species which attack crops appear to be usually forms of *Hoplotermes*, but exact observations on this point are very desirable.

It would be too long a task to attempt to recite all the objects which are attacked and spoilt by Termites. All articles of organic origin (wood, paper, clothing, etc.) are devoured, and even cases of tinned food have been known to be spoilt by Termites making their way into the wood of the case and bringing in wet mud, thereby rusting through the tins; some species are even known to be able to exude a fluid which is abl

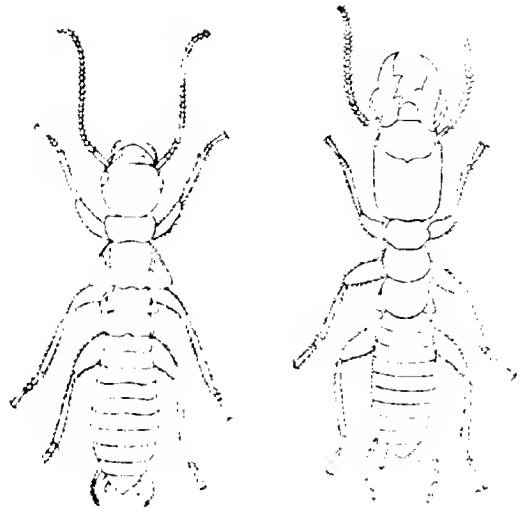
to corrode glass. In other parts of the world the amount of damage wrought is only equalled by the celerity with which the Termites select an opportunity for attack: thus we read of a Surveyor who returned to camp after a hard day's work and left his trunk on a table overnight: "the next morning he found not only all his clothes destroyed by Termites, but his papers also, and the latter in such a manner that there was not a bit left of an inch square. The black lead of his pencils was consumed, the clothes were not entirely cut to pieces and carried away, but appeared as if moth-eaten, there being scarcely a piece as large as a shilling that was free from small holes: and it was further remarkable that some silver coin, which was in the trunk, had a number of black specks on it, caused by something so corrosive that they could not be rubbed off even with sand." Many other instances might be given, as of the Termites which "one night, in a few hours, pierced one foot of the table, and having in that manner ascended, carried their arch across it, and then down through the middle of the other foot, into the floor." Most residents in India, however, know by bitter experience how swiftly destruction may be wrought, even if their lot does not equal that of the prisoners in a certain Indian gaol who awoke one morning to find that their bedding had been eaten up whilst they were sleeping on it.

There is a large and rapidly increasing literature on the subject of Termites generally, but it is a matter for regret that many inaccurate statements have been put forward with regard to the habits and economy of these insects. This has arisen very largely from the fact that a false analogy has been drawn between Termites and the true Ants on account of the social habits which they practise in common; but, although there are some general similarities in the economy of these two groups of insects, the parallel cannot be pushed too far and made to include minute details. Other authors again have drawn similar analogies from a consideration of Termites alone, and from observations on the habits of a few species have argued similar habits in others. It is very certain however that different species have

widely different habits and that it is very unsafe to deduce the details of the life-history of one species from the knowledge of those of another. Every species must be studied and treated on its own merits. To the ordinary practical man a knowledge of minute details may seem to be of little use, and it may appear a matter of small moment whether one species does or does not build mounds or whether the individuals of its soldier-caste have a dozen or fifteen joints to their antennæ; but if these seemingly trivial differences are found to be correlated with other differences, such as taste for particular kinds of food, they may prove to be of great practical importance.

It would naturally be expected that we should have a good knowledge of at least the different kinds of Termites which occur in the Indian Region, but it is a regrettable fact that this is by no means the case. Although India is the habitat of many species whose habits delight the observant naturalist and others which interest the systematic worker in the strangeness of their structure or the peculiarity of their geographical distribution, the Termites of India and Burma seem to have suffered a strange neglect at the hands of collectors and observers of insects. A certain amount of work has been done, especially within the last few years, on the Sinhalese species, of which over thirty distinct forms are now known to science, whilst only about a score are known at present from the whole of the Indian Peninsula (including Burma), although it is probable that at least one hundred distinct forms really occur. I may add here that I shall be pleased to receive specimens from any part of India or Burma and will gladly send full instructions for collecting to any reader of this Journal.

To the Entomologist one of the most interesting species is *Archotermopsis wroughtoni* (page 223), which is said to occur commonly in Kashmir in old stumps of *Pinus excelsa*. It is a large species with a soldier nearly an inch in length and appears to be one of the few surviving members of a group of Termites which is chiefly known to us from fossil specimens which have been preserved in Baltic amber.



WOOD-DESTROYING TERMITES.

Another interesting group is composed of the members of the genus *Hodotermes* (page 224), in which the workers and soldiers are over half-an inch in length and are remarkable in possessing well defined eyes, these castes in Termites being without eyes as a rule. Although one species was described from India over 130 years ago, we still know very little of their habits. In spite of their large size and the ferocious appearance of their soldier-caste, they seem to do very little harm, confining their depredations to bits of grass and leaves which they cut into short lengths and carry down into their nests, from which they come out to forage in broad daylight.

A group which is of considerable practical importance is that which includes the genus *Leucotermes*, containing *L. indicola* and other species which are very destructive to timbers used for constructional purposes. Beams, rafters, furniture, clothes, books little comes amiss to these voracious insects, which apparently live in comparatively small colonies within the beams, etc., which they attack

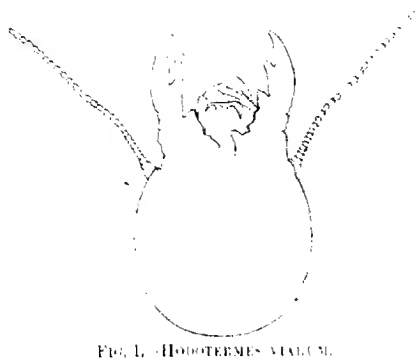


FIG. 1.—HODOTERMES VIATICUS.

FIG. 2.—COPTOTERMES SP.

FIG. 3.—LEUCOTERMES INDICOLA.

FIG. 4.—EUTERMES HEIMEMS.

FIG. 5.—TERMES OBESUS.

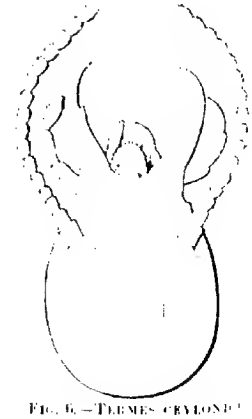


FIG. 6.—TERMES CEYLONICUS.

Within the limits of a short article, it it impossible to do more than mention a few species in particular. *Coptotermes* forms a group known as "Latex Termites" from the drop of sticky milky fluid exuded by the soldiers to repel attacks of enemies: *C. gestroi*, described from Burma, has achieved notoriety by its attacks on Rubber-trees in the Malay Peninsula, and Professor Watase informs me that this same species is a very serious pest in Japan where it causes great damage to wooden structures of all kinds. *Eutermes* has in many species two distinct forms of the soldier caste, a larger and a smaller, but both agree in having the front of the head prolonged into a long tubular beak. In *E. biformis* the larger form of soldier ejects through this beak to a distance of two or three inches a very fine jet of sticky secretion which hardens immediately it comes in contact with the air and forms a fine viscous thread. In a nest of this species which I opened up at Parantij there was a small accumulation of short lengths of grass-stems, and this species apparently does not feed on wood. In Ceylon an allied form (*E. monoceros*) makes its nest inside hollows of trees and issues out at sunset in a long regular procession to gather lichens from off neighbouring tree trunks. Considering that these insects are totally blind, the regularity of their line of march is truly wonderful. The workers march along in a solid stream, 8 or 10 abreast, whilst the soldiers take up their position on either side of the route, facing outwards ready to repel attack. The size of one of these armies is best realized by considering the fact that it takes about five hours to pass a given point at the rate of one metre in a minute and, as one metre of the procession may contain between 800 and 1,900 Termites, simple calculation shows that a single army of foragers may amount to a quarter of a million individuals or even double this number. Arrived at the tree previously fixed on by the soldier-scouts sent out ahead of the

* A detailed and extremely interesting account of the habits of this Black Termite is given by Professor Bugnion in the Annals of the Entomological Society of France (1909, pp. 251–281) and in the Bulletin of the Vaudois Society of Natural Sciences (Vol. XLVII, pp. 117–137). T. B. F.

main body, the workers proceed to scrape off the lichen with their jaws, and in this work an admirable plan of division of labour is adopted. Had each worker to hold in its mouth the lichen already collected, the movements of its jaws in scraping off a further supply would be seriously embarrassed. The whole army is, therefore, divided into squads of six or seven individuals, one of which holds in his jaws the fragments of lichen scraped off by his fellows, who are thus enabled to gather a large supply in a comparatively short time. Towards dawn the army prepares to return to the nest in reverse order to that in which it started, the soldiers continuing to line the route and forming up as a rear-guard after the workers have passed. Such regularity in the order of the procession, such division of labour and such mutual help would doubtless be ascribed to intelligence if carried out by animals higher in the scale of nature, and our admiration must be increased still more on reflecting that these tiny insects are totally blind.

It is the members of the typical group *Termes* that are most familiar to the ordinary observer as it is the activities of these species which are usually the cause of the well-known "White Ants' Nests" or mounds. Probably we have a large number of different kinds in India, but it is not every form which makes a mound. Some pass a life of concealment underground and are rarely seen except when the winged forms swarm out at the beginning of the rains; in others, the position of the nest is clearly marked by a mound which may vary from one or more insignificant looking heaps of earth a few inches high to a single conical pinnacle towering up to fifteen feet or more. In comparison with a really tall Termites' nest, the "sky-scraper" of our modern cities sinks into insignificance; basing comparison on the relative lengths of a Termite and a human workman, the Termites' structure would only be overtopped by a building nearly a mile in height.

In the following remarks we will confine our attention to the group of common mound building species which are best known to the ordinary observer.

To understand something of the internal economy of a nest it is necessary first of all to glance briefly at the constitution of the individuals which compose it: these consist of (i) workers, (ii) soldiers, both of which castes are made up of sexually-immature males and females and (iii) of sexually mature males and females. Besides the foregoing there are of course immature individuals of each of these principal castes. All start from an egg, but it is not known whether all the eggs laid by a single female are similar; in the case of the honey-bee it is a well-known fact that only eggs fertilized by the male element give rise to females, and that the queen, when laying eggs in drone-cells, has the power to withhold the issue of spermatozoa from the spermatheca in which these are stored: there is however no evidence that this is the case amongst Termites, and it is probable that the Termite eggs are all extruded in an undifferentiated and fertilized condition, although this does not necessarily imply that the sex of the contained embryo has not already been determined. It is supposed that the ultimate destiny of each individual egg (*i.e.* whether it is to develop into a worker, soldier, or sexual form) is determined by differences in the food given to the newly hatched individual, but it appears that this view is based on analogy with what occurs in the case of bees rather than on actual observations; in the case of eggs which hatch in a large nest there may undoubtedly be a possibility of many different variations in food and feeding of the young individual, but it is difficult to see that there can be much choice of either in the case of the first batch of eggs raised by a solitary pair on the foundation of a new colony: yet we know from our own experiments that such a first batch of young does contain individuals differentiated into workers and soldiers. As the newly hatched young differ from the helpless grubs of bees in being able to walk about as soon as they emerge from the egg, it is also difficult to see how they can be restricted to one particular form of diet. Be this as it may, it certainly appears to be the case that Termites can, in some cases at least, exercise a certain amount of control over the ultimate destiny of immature

individuals, and can sometimes change into one form an individual which is already far advanced towards development into another caste. If the transformed individual does not attain satisfactorily to the standard of its new type, it is probably killed and eaten —*pour encourager les autres* a cynic might say, but the real reason is that an individual intermediate between two different forms would be incapable of performing completely the work of either, and the Termite community does not tolerate inefficiency in its members.

The various possibilities of normal development of an individual egg are shown in the table: the complications introduced by the development of neotenic sexual individuals have been omitted owing to want of evidence that "substitution royalties" are ever produced in the mound-building species now under consideration.

Numerically the most important individuals in the Termite-community are the "workers." Apart from reproduction and defence, these carry out practically all the duties required of members of a social body: they take charge of the young, excavate, build up and repair the nest, forage for food outside of the nest, and (in many species) attend to the cultivation of the fungus-gardens. Irrespective of age, there are often two forms, a larger and a smaller, whose functions do not appear to be greatly differentiated, though as a rule the larger forms seem to act as foragers, whilst the smaller individuals attend to the internal economy of the nest. The jaws in the worker are well adapted for cutting through fibrous substances such as wood, and it is the workers alone which damage crops and woodwork.

Amongst the social bees and wasps each worker is armed with a powerful sting which as a rule is used solely for defensive purposes. In the case of Termites, however, in all the more highly developed species the defence of the nest is provided for by a special caste called "Soldiers," which are entirely distinct from the workers structurally and whose business it is to keep order amongst the workers and to repel any assaults upon the nest or foraging-parties. The soldiers have no sting, it is true,

but are armed with large peculiarly-modified and often formidable-looking jaws and have also (in many species) the

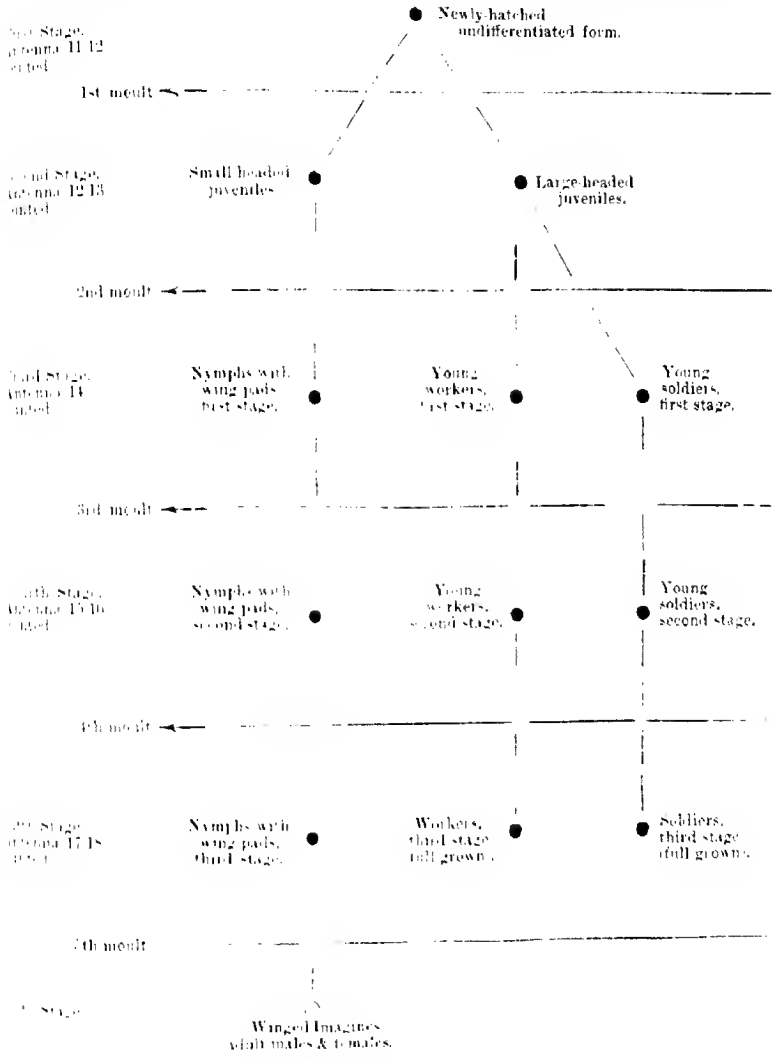


Table showing development of different castes of *Termes* sp. Adapted from Escherich. Substitution forms omitted.

power of discharging a sticky substance which blinds and disables their ordinary enemies and particularly ants. To us

their bites seem insignificant, their jaws barely piercing the skin and the sticky exudation doing no more harm than to leave a reddish-brown stain which persists for a few days. We do not seem to have in India any species so ferocious as are those in Western Africa: Smeathman relates of the soldiers of one of these that "if they get hold of anyone, they will in an instant let out blood enough to weigh against their whole body; and if it is the leg they wound, you will see the stain upon the stocking extend an inch in width." Possibly it was these same soldiers of which another traveller in West Africa gives the following quaint account:—"I one day attempted to knock off the top of one of them (Termites' nests) with my cane, but the stroke had no other effect than to bring some thousands of the animals out of doors, to see what was the matter, upon which I took to my heels and ran away as fast as I could."

The rôle of the soldiers appears to be solely to act as defenders of the nest, and in doing this they appear to realise the soundness of the military maxim that the best defence is a vigorous offence. In many species, the opening of the nest sees the immediate retreat of all the workers out of sight, while at the same time it gives the signal to the soldiers to swarm out and repel the disturber of the peace. Blind as they are, they seem obsessed with rage and run about with jaws open and ready to seize the foe. On meeting the intruding or any strange object, it is seized firmly in the mandibles, sometimes with such determination that the soldier will allow itself to be torn in two rather than relax its grip, whilst the sticky exudation is poured out copiously from the gland in the head. If no enemy can be found, the soldiers gradually retreat into the nest, whilst the workers bring up earth and repair the breach, but the soldiers continue to line the exposed galleries with their heads directed outward ready to meet any further assault.

Except by acting as escort to foraging-parties, the soldiers seem to take no part in procuring food for the community, and the extreme modification of their mouth-parts appears to prohibit them from feeding on hard substances such as wood. It seems

probable that they are nourished principally on liquid food discharged from the mouth or the rectum of the workers. In addition to this, they may perhaps fill the rôle of undertakers and find part of their sustenance in the bodies of their comrades, either those which may have died in the nest or those marked out for execution as being unsatisfactory in their development.

In some species (more especially in *Eutermes*) there are two or more forms of the soldier-caste, characterized by distinct differences in size and in the shape of the head. In this respect there is a close parallel with many species of true ants.

The individuals which are destined to mature true sexual characters are distinguishable in early life by their larger size and by the possession of small pads which will later on develop into wings. These nymphs with wing-pads may be found in some nests at almost any season of the year, but are most common in the spring at the beginning of the dry hot weather: at this time batches of twenty or thirty at a time may often be found in small chambers within the nest: they do not seem to be provided with fungus comb as a rule, and it seems probable that they do not eat fungus, but are fed in a special manner, either by food predigested and disgorged by the workers or perhaps on the "red bodies" which will be noticed later on. Just before the rains begin, these nymphs attain the perfect state and, on the occurrence of the first heavy shower, issue out of the nest in the swarms which are such a feature of this period of the year. Comparatively very few escape the numerous enemies which prey on them the moment they emerge from the nest. Ants, lizards and ground feeding birds catch them before they have time to take to flight, and even in the air birds and bats and dragonflies pursue them relentlessly; even man himself does not disdain the dainty fare, which is said to taste like sugared cream and almond paste.

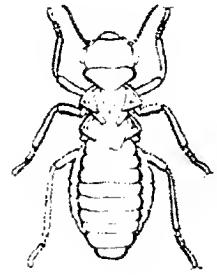
Aitken's account of the emergence of a swarm is at once accurate and amusing: "As each young adventurer drew itself through the narrow gateway, arrayed like a bride in its long

gauze wings, it bade a tearful farewell to the friends of its childhood, and, rising upon the breeze, started upon the voyage of life. I do not know what rosy hopes were at that moment blushing on the horizon of its young life, but a king crow shot from his station and wiped them all out with one loud snap of its beak. In half a minute a second rose on its feathery wings and sailed away towards the sky, until a swallow-shrike seemed to glide over it, and it disappeared. No beak snapped this time. The bird just swept past with open mouth, and the ant was not.....Thus, one after another, each in happy ignorance of the fate of its predecessors, they went forth to seek their fortunes, and the fortunes of all were the same. I doubt if a single one

WINGED INDIVIDUAL

came to a happy end." A few however do survive, and shortly after the swarm has emerged a few individuals may usually be seen resting on grass-stalks, etc., head downwards, with the abdomen raised and tremulous and the wings quivering: at this time they emit a heavy sweet, honey like odour which is doubtless attractive to the opposite sex. As soon as the mate has been attracted - and often before this - the wings are shed, being thrown off voluntarily by a jerking motion, whereupon each wing breaks off along a natural transverse suture near its base, leaving

a small stump attached to the thorax. Two or more individuals are often seen running rapidly along the ground in single file at this time in search of a suitable crack or hole in the soil in which to commence a new nest. It has been denied by some observers that these winged individuals are capable of founding a new colony by themselves: that they can do so in the case of *Termes redundans* we have been able to prove at Pusa in the summer of 1911, when a pair of winged individuals which had swarmed out of a nest on 25th June was kept in confinement and successfully laid eggs by 9th July and reared fully-developed workers and soldiers within three months, when the experiment was unfortunately terminated by mischance. In 1910 also



ALATE MALE AFTER SHEDDING WINGS.

winged individuals were collected from a swarm on 23rd June and by 29th June had laid eggs which hatched on 15th July. The parents did not stir from the small cell which they had constructed and did not appear to feed at all: probably on first emergence from the nest they contain enough nutriment to meet their own needs and those of their young until these latter are sufficiently developed to go out foraging. Some observers have stated that the reproductive organs of these winged individuals are immature at the time of swarming and that they are not developed until a considerable time afterwards: the dates of oviposition given above appear to disprove this in the case of *Termes redundans* and, furthermore, in digging up next day the mound whence a swarm of this species had emerged on 24th

June 1911, a pair was found coupled, though unfortunately they were dead; one individual had shed its wings, the other still retained them.

The few pairs which are sufficiently fortunate to find a suitable site, usually in some small crack or cranny in the ground, commence the foundation of a new nest by preparing a spherical chamber just large enough to contain them both. This they do by excavating the earth with their mouths and carrying it outside. The female then settles down to the more serious business of laying eggs, to which her whole existence is henceforth

ADULT FEMALE

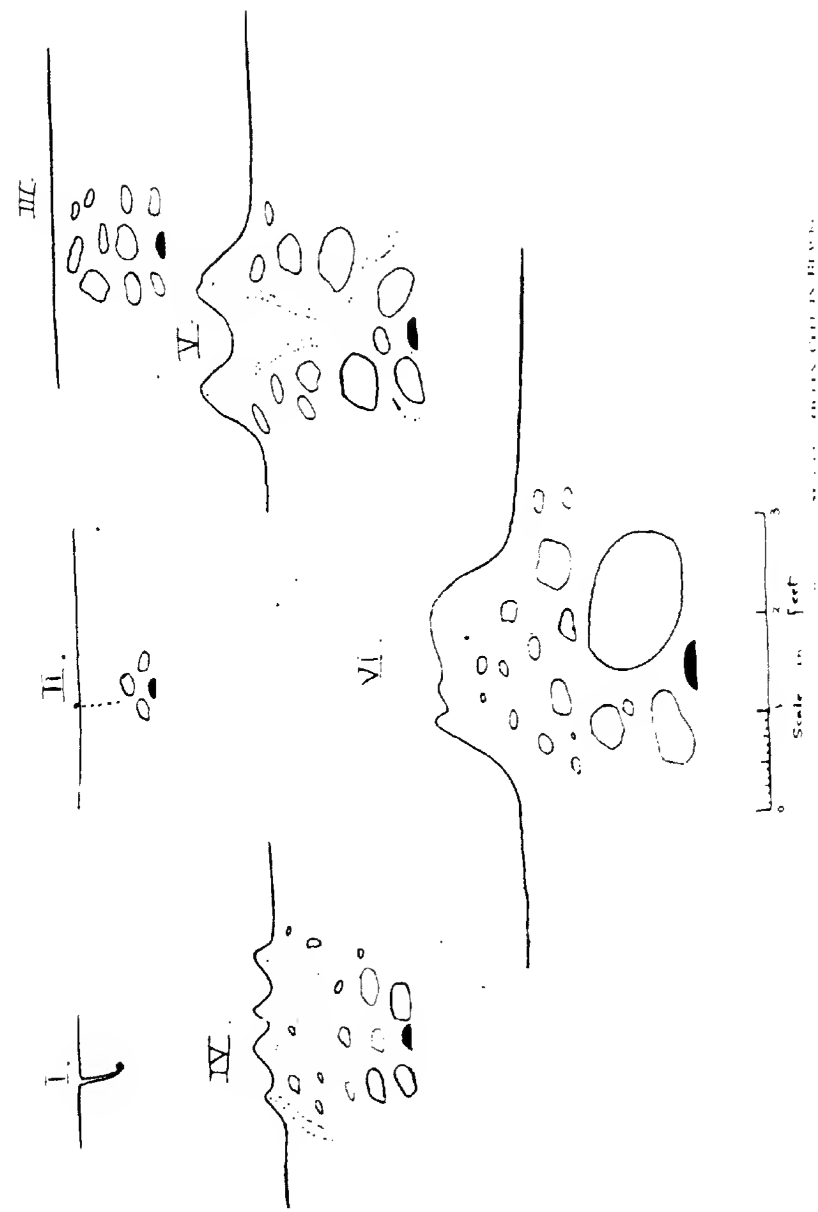
to be devoted. As the nest grows the body of the female swells until the brown chitinous plates which at first formed her back become merely little islands widely separated by an expanse of white skin, and ultimately she develops into a monstrous unwieldy grublike animal, incapable of walking, a mere pulsating mass of eggs. How long it takes for the female to assume this monstrous shape we cannot say, but it is probably not less than two years certainly three months after emergence from the nest the female

shows no perceptible sign of enlargement, although by this time she has laid eggs and reared up young. The total length of life of a female is quite unknown, but (barring accidents, of course) it is probably not less than five years and may perhaps extend to ten or more years.

The rate at which the female lays eggs was stated by Smeathman to be sixty in each minute and this statement has been widely copied and repeated by subsequent authors. A female of *Termes sp.*, taken from a mound at Hoshangabad and placed under as natural conditions as possible, was found to have laid 359 eggs in fifteen minutes, a rate of oviposition which works out roughly at 34,000 in one day. When the female has attained these enlarged dimensions, she is indeed nothing but a vast reservoir of eggs, and their extrusion appears to be purely an involuntary action.

The growth of a mound-nest is apparently very slow at first, and it is probably not until after the first anniversary of its foundation that it becomes noticeable above ground. By this time its population has become very numerous and extension proceeds more rapidly. In some cases it appears that the building of a mound above ground level is due largely to the necessity for disposal of the earth excavated below ground in extending the cavity which contains the nest, and that the pinnacles of the mound form a kind of scaffolding around the mouths of the galleries up which the excavated material is brought. In other cases, however, in which the pinnacles are left open, they seem to act as ventilating shafts. The particular shape of the mound varies considerably and is usually characteristic in each species of Termite.

In localities in which the ground is liable to become water-logged during the rainy season, it is probable that the mound is also used more largely as a residential quarter than at drier seasons of the year when the population of the nest is found deeper down. From my own observations, I am led to believe that, in some cases at all events, the royal cell and nurseries for the young are moved up into the mound above ground-level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during the rainy months and are shifted again below ground-level after the rains are over. I have definite proof that a new royal cell may be built and the queen moved a considerable distance into it.

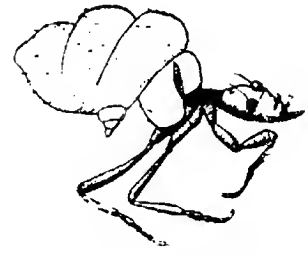
On opening up a mound nest, the first objects met with, at two or three inches below the surface, are often small chambers one or two inches in diameter and which contain small rounded masses of coarsely granular comb. These chambers are not made by the mound-builder, but belong to a small kind of *Microtermes*. On continuing the opening of the mound, we come upon series of larger chambers filled with a yellowish-brown spongy "comb" full of workers and soldiers of the mound-builder. These chambers communicate with one another by small galleries and usually increase in size towards the bottom of the nest. The larger and lower chambers are filled with very large masses of comb which swarm with small white immature Termites: these larger combs are what we call "nursery" combs and are characterised by their large size and the presence of newly-hatched Termites and of masses of eggs.

Nymphs (*i.e.*, immature winged individuals) are sometimes found in the comb, but more usually in small chambers without comb and situated in the upper part of the nest. With the nymphs, and sometimes in the nursery comb near the eggs, or even intermingled with these, are found masses of the small spherical orange-red objects which we have called "red bodies." The origin and use of these remain unknown. They are not of vegetable origin, and I have ventured to suppose that they may be a special food reserve, or royal food for the nymphs, prepared from partially-digested and regurgitated animal matter. The royal cell is generally found near the nursery chambers, its vicinity being indicated by the royal body-guard of soldiers which are to be seen in large numbers when progress of excavation approaches the queen's cell. This is surrounded by small galleries, large enough to admit the passage of the soldiers and workers attendant on the founders of the nest, but too small for these latter to pass. The cell is about four or five inches long by two or

three broad, with a flat floor and an arched roof, and contains the male and female. Occasionally two or more queens are found in one cell, but there never seems to be more than a single male.

The comb which fills these chambers is generally in the form of rounded masses, slightly concave on the lower surface, the exterior more or less corrugated and the interior filled with an intricate maze of intercommunicating passages. It is composed of very finely comminuted fragments of wood and other vegetable substances, from which the Termites have extracted all matter assimilable by process of digestion. The figures give a better idea of the general appearance of a comb than any verbal description.

Scattered over the surfaces of the combs will be seen small white stalked globules which represent the immature stages of

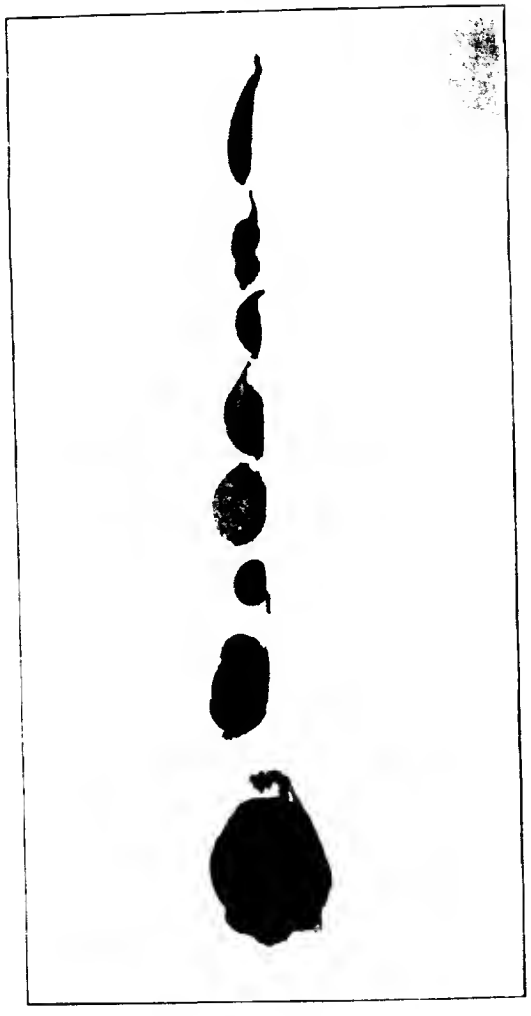


TERMITOMYIA HOLMI (p. 239).

a fungus which is cultivated and eaten by the Termites, for indeed the whole mass of comb seems to be built up expressly for the purpose of growing this fungus, upon the cultivation of which the well-being of the nest seems to depend to a large extent. In occupied nests these fungi are bitten off and eaten whilst still small enough to form a mouthful for the Termites, but in deserted nests the fungi grow until they appear above ground as small white mushrooms, whilst the resting stage (*Sclerotium*) which remains in the deserted chambers of the nest forms a hardened blackish object which at first sight would seem

PLATE XXVIII.

PLATE XXIX.



L. J. L. [illegible] OF NATAL

to have no connection with the small fungus grown on the comb. The fungus commonly found is *Xylaria nigripes*.

One of the most interesting subjects in connection with Termites' nests concerns the various other animals which live associated with the Termites. Numerous small beetles and flies are found, especially in the nursery-combs, where they frequently prey upon the eggs and young of their hosts, by whom they are tolerated, or we might even say domesticated, on account of their exudation of some liquid agreeable to the Termites. It is impossible to attempt to give here a list of these "termitophilous" insects, but amongst the most curious are the strange-looking wingless flies of the genus *Termitoxenia* of which there are at least three species in India

CO-OPERATION IN AGRICULTURE.

By W. H. BUCHAN, I.C.S.,

Registrar, Co-operative Credit Societies, Bengal.

THERE has recently been published a collection of monographs* which trace the history of the Co-operative movement in the principal countries of the world. The volume is commended to the attention of those to whom agricultural interests appeal. It is a revelation of the power of a new economic force which has its beginnings in remotest history.

To the ordinary Englishman the word Co-operation suggests vaguely a form of urban shop-keeping. In Great Britain co-operative methods have made little headway outside the towns. The country is still one of large holdings farmed by men, individualist by instinct, who have not yet felt the need of combination. If the movement towards small holdings, inaugurated by the Act of 1907 and officially blessed by both parties, develops, it will shortly be found that an effective co-operative organisation is an indispensable condition of success. But for the present we must look to Ireland and to foreign countries in order to see what co-operation in agriculture can effect.

These monographs tell the story: it is a plain tale of facts and figures, all the more remarkable because it covers a period of little over 50 years. Last century was one of awakening and activity in every branch of human affairs. The strain and competition and the progressively centralising tendency of commerce and industry reacted on the agricultural world

* *Monographs on rural co-operation* [illegible] published by the International Institute of Agriculture, Rome.

The stress of life grew steadily harder: a growing population demanded more intensive cultivation and a more productive soil, and these could be obtained only by utilising the costly improvements of technical science: while the increasing opposition of the commercial world and the growth of outside economic concentration compelled the closest attention to the interests of agriculture. Had the small farmer clung to his isolation he would have gone to the wall. Fortunately, when the economies and saving power of association for common ends were demonstrated to him, he developed a genius for it. The amazingly rapid development of co-operation is the one great fact of recent agricultural history in Europe: it extends not to one or two countries or to certain branches of agriculture, but to every country where the small holder exists and to every department of rural economy. And the movement has been wholly for good. In towns association is to some extent a dividing force, applied to the defence and assertion of sectional and class interests at the expense of others. But in rural areas it is more purely utilitarian and is generally a bond uniting all classes.

India, short though her co-operative history is, occupies a serious place in this volume. The inclusion of her monograph is useful, because it brings her methods and lines of work and results into prominent contrast with those of other countries. The comparison is instructive, and those who are interested in the Indian movement will find the volume suggestive and illuminating.

Of all the points of variance by far the most prominent is the relation of the State to the co-operative movement. The uncompromising opponent of State assistance in any form will find no support in these monographs. There is no country which does not accord more than mere legislative recognition to the co-operative idea. The aid is rendered variously in different states, in the form of legal privileges, assistance in propaganda, financial facilities, direct subvention, and otherwise. One may hold that the State aid is often unnecessarily and sometimes injudiciously given. One could prove that where the movement

is strongest dependence on the State is lightest. Yet on the other hand it is not to be denied that the help of Government has been of great service in most countries and especially to certain branches of co-operative work, and that but for that help co-operation would not be the vigorous growth that it is to-day. State aid is not a principle to be condemned or approved in the abstract. There is a time to give and a time to withhold aid. Like every other principle it is relative, and must be applied with direct reference to the circumstances of each country and people and the requirements of each form of co-operative activity.

But the writers of these monographs hold no brief for State aid. Their straightforward narrative ought to convince the straitest theorist that there are circumstances in which such assistance is permissible and even advisable, and that it is a matter on which a man may not dogmatise. But no attempt is made to uphold State aid as a good thing in itself. On the contrary, the inference everywhere is that a completely self-reliant movement is the ideal, and that Government assistance is only a means to that end—it can never be a substitute for popular inspiration and direction. The essential thing to notice is that in Europe the initial impulse has invariably come from the people. The co-operative idea was evolved to meet changing economic conditions by those who actually felt the pressure of them. Only when that idea had been put to the test of practical working and its efficacy proved did the State come forward with its assistance—an assistance which was not always gratefully received. First and above all things the movement in Europe is a self-conscious and popular one, deriving its impetus from private enterprise and dependent upon its appeal to the people's sense of interest.

It is here that the Indian movement occupies a position by itself. The writer of the monograph on India sums up the progress made as "an illustration of State aid effectively administered rather than of organised self-help." We reversed the normal process by beginning at the top. Government not only introduced the idea to India but appointed officials—Registrars to make it known and to organise and guide a

co-operative movement. It was the only possible course. The condition of agricultural India obviously called for co-operative societies, although the people had not thought the matter out and there was no conscious demand for them. The great danger of the arrangement was the possible officialisation of the movement. Every Registrar on his appointment at once becomes an enthusiast. He is convinced, and rightly, that a widespread co-operative system would mean the regeneration of the rural population. But he finds that the educated classes, the natural organising agency, are apathetic, and the temptation to form societies by official means is strong. The reports show that in most provinces this temptation has been resisted. In India, as in every other country, the teaching of experience is that excessive artificial fostering produces a weakling growth. Government has shown the way. There are in every province the beginnings of a healthy movement which grows more self-conscious every year, and which is gradually attracting the interest of the educated classes. The future rests with the people of India. An officially run movement on a wide scale is a thing unthinkable. A popular movement, appealing consciously to the interests of the agricultural classes, under general official guidance, but supported by the energy of numbers of local organisers, is eminently practicable. That is the ideal aimed at. It is certain that without that propelling popular force the movement can never have vitality or spontaneity.

India is predominantly an agricultural country. Agriculture in its many phases is by far the most important interest, and merits the greatest share of attention. Much has been done and more attempted to improve the situation, but the picture is still dark enough. The agriculturist, the pillar of the State, is paradoxically its weakest member. To the Mahajan's credit one may, almost without exaggeration, apply the celebrated phrase attributed to Louis XVI that it "supports agriculture as the rope supports the hanged." From first to last the ordinary ryot is dependent on that credit; he is scarcely even a free agent. His methods of cultivation are primitive and ofte-

wasteful, and in disposing of what crops he gets he can only accept such prices as the middleman chooses to offer. Weak and isolated, he is in no position to improve his fortunes. And the economic conditions are rendered harder to assail by the conservatism of centuries and the improvidence that accompanies blank poverty. The picture has been painted a hundred times.

It is possible that four years' work in connection with co-operative societies affects one's sense of proportion. But there is no one who has taken part in the work who does not regard co-operation as incomparably the most promising means of attacking the agricultural problem. And a perusal of these monographs confirms that conviction. To compare agricultural Europe of the present day with the same Europe of the early 19th century is to gain fresh hope for India. If rural India is backward and her outlook discouraging, there was a time when continental Europe was little better. In the change, astonishing both in its magnitude and rapidity, that has taken place in the West co-operation is probably the most important factor. Rural credit has been reorganised. The co-operative society enables the small farmer to cultivate scientifically, to get good seed and manures and agricultural machinery at cheap rates, to sell his crops to the best advantage while avoiding the profit of the middleman, to manufacture his dairy produce and sell it in the best market, to improve the breed of his live stock and to insure his possessions against all risks. These are only a few of the directions in which the co-operative principle has been applied. The movement encourages agricultural education and reaps the benefit of improved cultivation and a stronger and more intelligent force within itself. The societies form practically a huge unpaid agency for making known and bringing into practical use in all parts of the country the improvements of agricultural science and economy.

Unless such a development is regarded as attainable in India our present work is meaningless. We are still a long way off it, and before it is reached there is much to be done in the way of education and the breaking down of old prejudices and habits

But the instinct of association is deeply implanted in the people, and the success that has attended the first experiments in co-operative credit offers the promise of greater things in other directions. Hitherto the departments of agriculture and co-operation have worked independently. In future their orbits must increasingly converge. When the scientific department has demonstrated the value of a particular method of cultivation or of an improved implement, the co-operative society ought to supply the channel, so greatly wanted, by which these improvements will be carried down to the ryots. Even now some use is made of the societies in this direction, and more might be done. If the two departments so work together, and if, most important of all, the people themselves and especially the more enlightened classes co-operate, the history of the next fifty years will have much to tell of improvement in the lot of the Indian peasantry.

A SERIES OF CAMPAIGNS AGAINST THE RICE GRASS HOPPER *HIEROGLYPHUS BANIAN, FABR.*

By T. F. MAIN, B.Sc.,

Deputy Director of Agriculture, Bombay

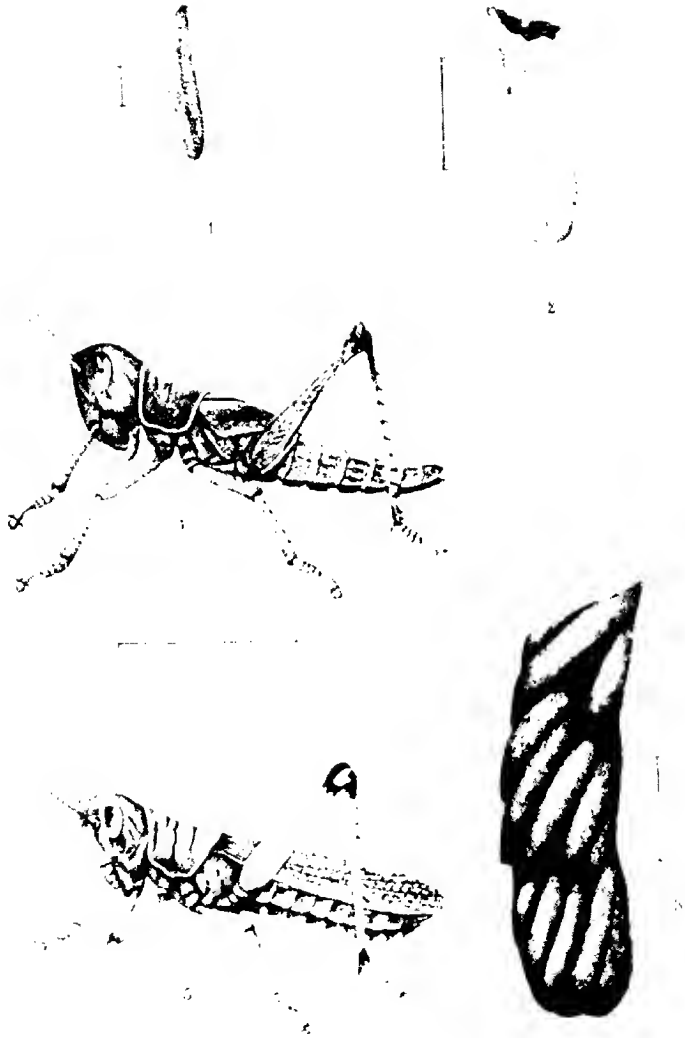
This insect has been described and its life-history very fully recorded in a recent publication of the Department of Agriculture of the Mysore State. For the purposes of the present article it is only necessary to indicate briefly the leading characters of this grass-hopper, and in doing so I shall draw largely on the publication referred to above.

Description.

2. Eggs are laid in masses in holes in the ground towards the end of the rains. The exact time varies with the nature of the season, but this generally takes place between October and December. A female lays from 100 to 150 eggs and selects soft ground for the purpose, as for example the base of the bunds which surround the fields. Laying in the middle of the paddy-field as well as on the bunds is also common. The exact location depends a good deal on whether the crop is still standing when the laying commences, because the hoppers prefer to remain in the standing paddy, and only leave it when the latter has been cut down. The eggs remain in the ground till the beginning of the following rains, when small hoppers

(1) Entomological Series (Mysore State) volume No. 1. The rice grass-hopper by Lieut.-C. Coleman, M.A., F.E.S., assisted by K. Kunhi Kannan, M.A.

(2) Coleman states that this rarely happens in Mysore and affirms that laying is confined to the grassy bunds which surround paddy-fields or to the river mounds.



Red Grasshopper

EXPLANATION OF PLATE XXX.

The Rice Grass hopper (Hieroglyphus banian, Fabr.)

Fig. 1. An egg taken out of a cluster

„ 2. Egg cluster with crust on it.

„ 3 Egg cluster with crust removed

„ 4 Young grasshopper, fourth stage.

„ 5. Full grown male.

about $\frac{1}{4}$th of an inch in length hatch out. These grow rapidly, and pass through 6 or 7 moults at intervals of 10 to 15 days before becoming adult insects, when they measure about one inch in length. The newly-hatched hopper is similar in appearance to the full grown insect, except that it does not possess wings. The young hopper has a yellowish brown appearance which changes in the course of successive moultings to green or yellowish green in the adult insects. The prothorax of the full grown insect is marked above and laterally with four somewhat irregular transverse brown or black lines. The lower surface of the insect is brownish black, while the middle division (tibia) of the posterior leg is blue (*vide* Plate XXXI). The adult insects fly regularly for short distances—20 to 30 feet when disturbed.

This grass-hopper has been observed at Belgaum for the last 15 or 20 years as a pest on the paddy crop, but there is evidence to show that the damage sustained has greatly increased in recent years. It is also a well-known pest in many other parts of India, notably the Central Provinces and Mysore. Paddy appears to be its favourite food crop, but it is known also to attack sugarcane, *jowar*, maize and *bajri* without assuming the proportions of a serious pest. To paddy, however, this grass-hopper is very injurious; it devours the leaves and cuts through the stems, thus causing much greater damage than is represented by the portion eaten.

Previous Preventive Measures adopted.

3. The first official notice taken of this pest in the Bombay Presidency was in 1904, when the Director of Agriculture, Mr. Lawrence, brought to the notice of the Collector of Belgaum the preventive measures which had proved successful against the same pest in the Central Provinces. About a year or two previously the Central Provinces' Administration had appointed a special officer, *viz.*, Mr. Steckman, to investigate the damage done by this pest and if possible devise some means of prevention. That officer designed a huge net measuring 36' × 4' to be dragged over the paddy-

fields, and this method proved a useful means of catching the hoppers. Accordingly during the years 1904 to 1906 the Collector of Belgaum made several attempts to apply this method of catching the hoppers, but, on the whole, very little progress was made. In the first place the work proved very expensive. Each net cost Rs. 10 and a dozen men and boys were required to work it, costing Rs. 2-4-0 per day, during which time about one acre of paddy was worked over.(1) The expenditure of dragging an infected area of 3,000 acres was estimated at Rs. 6,500 exclusive of the initial cost of Rs. 1,000 for nets, and the supervision charges. For this reason the operations had perforce to be restricted to a small scale, and this arrangement was found to work very unsatisfactorily, for it soon became obvious that to drag only a part of the infected area was of very little use because the hoppers from the other fields rapidly spread back over the fields which had been dragged.

4. Efforts were made to induce the people to take up the work on contract, but no one came forward. The cultivators themselves took little interest in the operations, and many of them—the Jains had religious scruples against taking part in the work as they considered destroying any form of life to be sinful. In fact the prevailing opinion among the people was that this insect pest had been inflicted upon them by God and could only be removed by Him. In the end it was recognized by the Collector of Belgaum that the pest could only be completely cleared from the fields by the adoption of vigorous methods for several years continuously, and as he had not the means of giving effect to these conditions, he abandoned the operations in 1906, and during the next three years nothing further was done.

Spraying Experiments.

5. In the meantime Mr. Lefroy had conducted spraying experiments at Belgaum: a preparation of Kerosene oil was

(1) To reduce expenditure a system of driving the hoppers into specially prepared nets was subsequently adopted.

sprayed upon the adjoining grass areas and lead arsenic was sprayed on to the paddy plants, but neither of these experiments proved successful owing to the prevalence of heavy rains which washed off the sprays as soon as they had been applied.

Operations in 1909.

6. The present narrative properly begins with the monsoon of 1909 when the Agricultural Department for the first time took up the problem. During that monsoon Mr. Ramrao Kasargode, Assistant Entomologist, was deputed to make a careful study of the pest and experiment with various preventive measures. First of all attempts were made to dig out the egg masses from the surrounding areas, but it soon became evident that this was not a practicable measure owing to the difficulty of locating them, thus necessitating slow progress and resulting in varying success. Spraying the rice with stomach poisons was also tried, but this also proved futile for reasons already explained. Mechanical methods were soon seen to be the only practicable means of destroying the hoppers, and accordingly attention was directed to designing the most suitable type of net for the purpose, as the nets used in 1904-06 had proved both expensive and unwieldy. Ultimately two sizes of nets were evolved a large one and a small one. The dimensions of the former were 12′ long and 3½′ deep, while the length of the smaller one was 8′ and its depth 3½′. In both cases the width of the open mouth was 3′. The nets were made of ordinary coarse gunny sacking costing 2 annas per yard of 45″ width and there were 2 bamboos, one upper and one lower, to keep the mouth of the net rigid. These nets cost Rs. 1-12-6 and Rs. 1-0-3 respectively. A solid 4-sided frame for placing in the mouth of the net was discarded in favour of the arrangement described above. The large nets are found very useful for working during breaks in the rains, while the smaller ones can be used more conveniently on wet days, and have the further advantage of being handier for clearing corners of fields. Two men and a boy are required to work one net. The men drag the

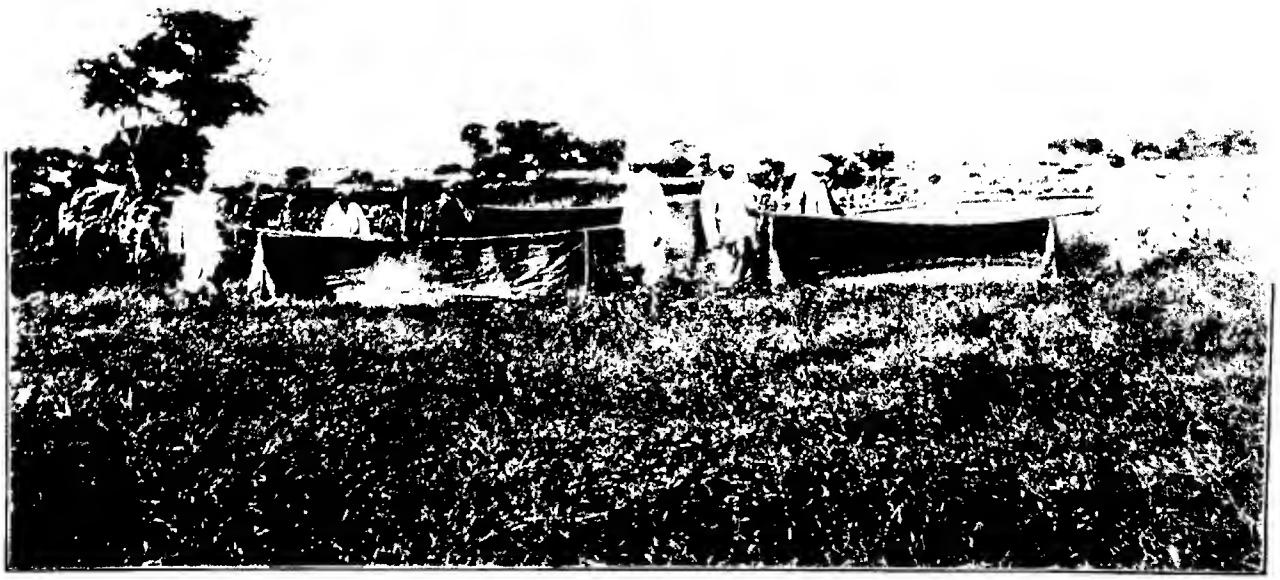
net at a sharp run over the paddy-fields and the boy is required to assist in removing the hoppers from the nets. The nets are worked against the wind so that they remain fully open, and the hoppers, in rising, thus become readily enveloped. The men hold the net by the upper bamboo which projects on either side (*vide* Plate XXXI). The lower bamboo should be slightly weighted so as to submerge it a few inches in the water. In this way any hoppers which drop into the water are readily caught. When the net reaches the end of the field its mouth is closed by bringing the bamboos together and the hoppers are destroyed.

One of these large nets can cover one acre once per day and catch one lakh of hoppers, if the latter are plentiful, at a cost of 10 annas.

7. After working out the type of nets most suitable for the particular conditions of the work at Belgaum attention was turned to persuading the people of the efficiency of this method, and much demonstration work was done involving an expenditure of Rs. 400 in all for the season's operations. At first the cultivators showed very little interest in the operations, but gradually some of the more advanced men undertook to give the nets a trial, and altogether 85 nets were given out free of charge. The work done, however, was haphazard and did not result in much success, though it demonstrated one very important principle, *viz.*, the necessity for co-operation and combined action.

Operations in 1910.

8. In the following year, 1910, a vigorous campaign was entered upon in good time on the 26th of July. Estimates were prepared in advance, and the Collector of the District opened a subscription fund. It was well that these steps had been taken for the pest was found to have increased six-fold since the previous year and the outbreak was the worst ever experienced up to that time. The area over which it was decided to operate extended to 5,000 acres, and for the purposes of the campaign this area was divided up into four blocks of



approximately 1,250 acres each and one *mukadam* in charge of 30 nets was assigned to each block.

Experience showed that the best work could be done during breaks in the rains. On sunny days it was found practicable when the hoppers were small and wingless for one net to drag one acre per day, but the actual area covered depended upon the relative severity of the pest. Subsequently when the hoppers got wings and when the water in the paddy-fields subsided the work became much more difficult, and the area netted per day greatly decreased so that on some occasions 10 acres could barely be dragged by 30 nets in one day. So long as there was water in the fields the hoppers could not escape below the bottom of the net's mouth which was slightly submerged, and those hoppers which fell into the water were thus easily scooped into the nets.

In practice it was found desirable to suspend operations on rainy days, because the hoppers in sheltering themselves from the rain did not rise readily and, therefore, could not be easily caught in the nets, and moreover the nets being wet did not swell properly in the wind

9. Two important difficulties encountered in the course of the season's work are worth mentioning. First of all there was again the apathy of the cultivators themselves which was largely due to the unsatisfactory relations which exist between landlord and tenant and which do not permit of the tenant deriving the full benefit of anything he may do to enhance the profits of the holding. The view taken by the cultivator was that if the pest was reduced the landlord would take the whole advantage resulting therefrom. This is a serious and permanent difficulty in the way of inducing the tenant to do anything for the general good of the holding. The other difficulty referred to above was the attitude taken up by surrounding Native States. There is a long boundary line along which the British and Native State areas meet, but none of these States would consent to co-operate in the work of hopper destruction, and hence the hoppers spread from these infected areas on to the British areas as soon as the latter had been dragged, and soon the conditions were as bad

as before, and accordingly special expenditure amounting to Rs. 200 had to be incurred to keep a gang of nets working along the boundary to prevent an invasion of hoppers from Native State areas. This proved effective until the hoppers got wings, when it had to be abandoned.

Operations in 1911.

10. The 1911 campaign was commenced on the 8th July and extended over 11 weeks till the 23rd of September. Mr Swadi, who had succeeded Mr Ramarao in the post of Assistant Entomologist, was in charge of the work. The general organization was similar to that described for 1910, but the area operated over was increased to 8,000 acres and a fifth *machalam* with his complement of nets was employed.

In this season, the Native States had reconsidered their attitude and agreed to co-operate in the work and contributed materially to the funds, and this was the cause of the enlarged area which was now constituted as follows (*vide* the map)

Territory	Name of villages.	Area in acres.
British	Belgaum Hosur Koilachi Kambargi	3,000
Kurundwad senior state	Angol Mariwadi	1,000
Kurundwad junior	Inam Belgaum Vadgaon Halga	1,000

A feature of the season was that the hoppers hatched out earlier than usual and were already present in large numbers before the paddy had even germinated, and accordingly they occupied the adjoining areas and bunds where they lived on the young grass. Attention was, therefore, first confined to these areas, and within a period of three weeks 120 million hoppers were caught off the grass; this was equivalent to two-thirds of the total catch of the season.

11. The season was favourable for conducting the operations as there was relatively a small proportion of rainy days. An

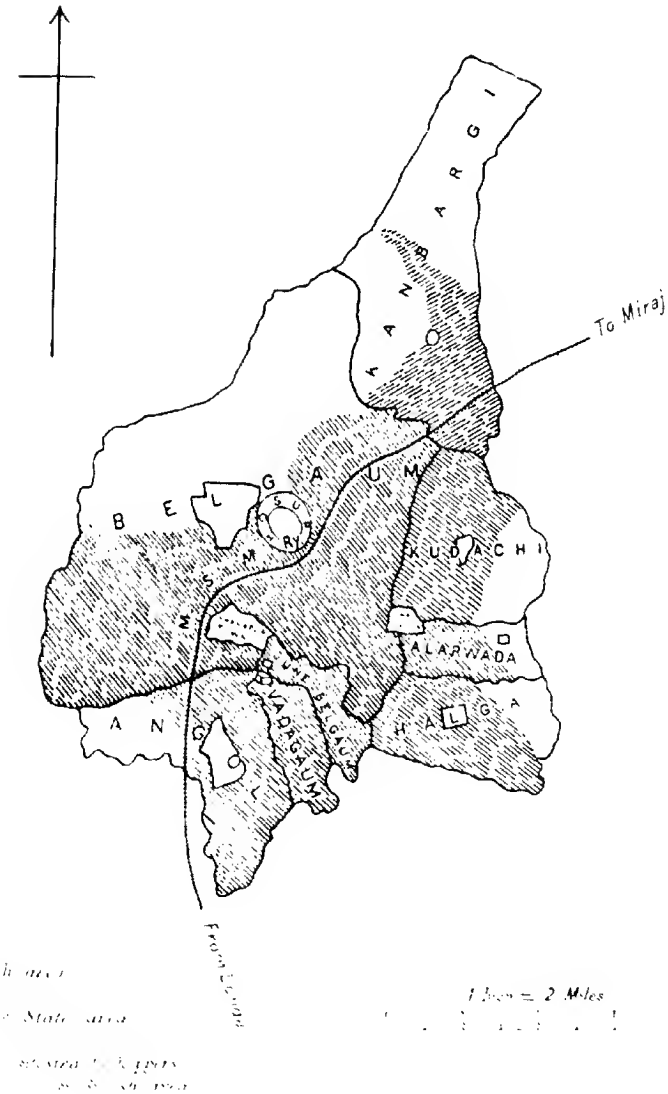
MAP

of

PORTION OF BELGAUM TALUKA

showing approximately the area infested by

HOPPERS



important change in the methods of procedure was introduced. This change was rendered necessary owing to the custom among cultivators of growing a sprinkling of *jowar* in their paddy-fields for fodder purposes. On account of the light rainfall, this remained in the fields for a longer period than usual, and, as a result of this obstruction, the nets could not be dragged over the paddy. A system of driving the hoppers towards the leeward side of the field, where open nets were kept ready for catching them, was accordingly devised and found to work well (*vide* Plate XXXII). In addition, however, the dragging method was adopted where possible. The driving system can also be used with greater advantage than the dragging system when the crop becomes tall and brittle as less damage is done to the paddy by the former method; moreover when the crop is tall the hoppers are liable to escape below the bottom of the net which must of necessity be worked at a rather high level. Generally, therefore, it was found that while dragging was preferable in the early stages driving was more suitable in the latter part of the season. Another point discovered as the result of experience was that when the hoppers were small the nets could be worked with better advantage after 10 A.M. in the morning, while when the hoppers were large the work should be done before 10 o'clock as the powers of flight are less in the early morning. By these means the whole area was gone over on two separate occasions, and on each of these occasions every field was dragged or driven as often as was necessary to completely clear it of hoppers.

In order to encourage good work small prizes were awarded weekly to the three nets which caught the largest number of hoppers. Another attempt at poisoning this pest was made in 1911 when criddle mixture was used but without success. At the end of the campaign, when it was no longer possible to net these insects, attempts were made to destroy those few hoppers which had escaped destruction and which were then copulating and laying eggs. This, however, did not prove practicable owing to the hoppers remaining within the standing paddy.

Results achieved.

12. There are two ways in which the value of the work may be estimated. We may first consider the numbers and weights of the hoppers destroyed. These were as follows:

Years.	No. of weeks during which operations were conducted.	Area operated over in acres.	No. of hoppers destroyed.	Weight of hopper destroyed in lbs.
1910	9	5,000	73,84,21,200	61,518
1911	11	8,000	18,59,85,000	1,02,467

It will be observed that although the working period was longer and the area much greater in 1911, still the catch was only about one quarter that of 1910. This may perhaps with fairness be ascribed to the effective work conducted in the preceding year.

The other method of estimating the value of the work is in terms of the crop saved. This is rather difficult to do, but in 1910 the following rough computation was made after taking into consideration the effect of the pest on the 1909 crop where no operations had been conducted:

Area operated over in acres.	Estimated area which would have been destroyed during the hatching period but for the operations in column 1.	
	One-fifth of area.	Ten times area.
10	1·25	6

Now a 12-anna crop of rice at Belgaum is taken at 3,800 lbs. per acre, and in an average good season the paddy is worth 40 lbs. per rupee. Therefore, over an area of 5,000 acres these figures show that the crop had been saved to the extent of Rs. 2,23,211 or approximately 2¼ lacs of rupees.

In 1911 the Revenue authorities valued the paddy crop at 8 to 12 annas, and this was a season when the rainfall was deficient. At the conclusion of the 1911 operations, there was an unanimous opinion expressed both privately by the landlords and

ryots and also in the local vernacular press that the work had proved very successful and had resulted in a very large financial gain to those concerned in paddy cultivation.

Expenditure.

13. These operations were financed largely by subscriptions contributed by the cultivators and Government made up the balance. In 1910 the total expenditure amounted to Rs. 2,269-0-0 of which Rs. 1,619-0-0 consisted of subscription money. In 1911 the total expenditure amounted to Rs. 3,650, of which Rs. 1,850 were subscribed. The greater expenditure in 1911 was due to the larger area operated over. In both years the chief item of expenditure was the labour bill. This amounted to Rs. 1,690-6-9 and Rs. 2,854-11-6 in the seasons of 1910 and 1911 respectively. The remaining expenditure was incurred in the purchase of materials and the pay of establishment. This latter item did not include the salary and allowances of the Assistant Entomologist who directed the operations.

Impression made upon the cultivators.

14. In the early stages of the work, and in fact until the effectiveness of the operations became apparent, the cultivators remained extremely apathetic and few, if any, came forward to enrol themselves in the daily labour that was hired, or exhibited any particular interest in the work.

Subsequently the less conservative men recognized the value of the work, and even among Jains there were many contributors to the subscription list, some of whom expressed their willingness to subscribe at the rate of 4 annas on the rupee of assessment in order to have their fields cleared of hoppers. As time went on, cultivators began to visit the quarters of the Assistant Entomologist and petitioned the latter to give preference to their fields over those of others, and ultimately many cultivators borrowed nets with the intention of dragging their own fields, a satisfactory feature in view of the fact that these were the men who had previously expressed the opinion that the

pest could only be successfully removed by some super-human agency.

Conclusion.

15 The success which has attended these operations must be largely ascribed to the good will of the Revenue Department. All the local officials, from the Commissioner and Collector downwards, took a great interest in the work and gave the Agricultural Department the full advantage of their moral support which is an indispensable factor in operations of this nature. Further work is still required to prevent the pest increasing again, and it is the present intention to renew operations in the coming monsoon. It is hoped, however, that the Belgaum cultivators, will, in the course of time, adopt netting as a regular operation in the routine of paddy cultivation just as weeding is now included.

HEVEA RUBBER IN SOUTHERN INDIA.

By Rudolph H. Anstead, B.A.,

Director of Experimental Research Agency to the United Planters' Association of Southern India.

History.

Hevea Rubber was introduced into the East through Kew in 1876. In 1877 Colonel Beddome, Conservator of Forests, suggested that some of the plants should be put down near Nilambur. This suggestion was not carried out, but in 1879, twenty-eight plants were received from the Ceylon Royal Botanic Gardens and planted at Nilambur in June, and in 1886 three more were received from Mr. F. J. Ferguson, who was experimenting with rubber at Calicut. These trees were neglected, and many of them were allowed to die, and the experiment was considered a failure by the Forest Department until 1903 when Mr. Proudlock, the Curator of the Government Gardens and Parks on the Nilgiris, reported favourably on the West Coast country as suitable for rubber planting. One of the surviving trees at Nilambur gave a yield of 1 lb. 3 oz. of rubber in 1903.

The first rubber estate in South India was opened in 1902 at Thattakad on the banks of the Periyar River in Travancore. This was followed in 1904 by estates in Mundakayam and South Travancore, and in 1905 by estates in Cochin, while since then many estates have been opened, in these districts and at the foot of the Wynaad and Nilgiri Hills, in the Nilambur Valley and its neighbourhood, which saw the first half hearted trial of Hevea. This district was graphically described by Mr. Proudlock in his report as "the arena of part of a vast amphitheatre of mountains formed by the Velarimalay range on the north west, the Wynaad

Plateau (3,000 ft.) on the north and north east, and the Nilgiris, with their grand peaks towering from 6,000 to 8,000 ft. in height, on the east and south east."

The acreages under Hevea Rubber in 1911 with the estimated yield of rubber are given in the following table for the chief rubber growing districts of Southern India :—

District.	Area under Hevea Rubber in 1911.	Estimated yield of Rubber.
Malabar	7,000 acres	
North Travancore	2,251 ,,	150,000 lbs.
Mundakayam	9,652 ,,	140,000 ,,
South Travancore	16,368 ,,	120,000 ,,
	and 1,530 with Tea.	
Cochin	3,735 acres	
Shevaroys	1,859 ,,	

Cultivation.

The trees are usually planted 20 feet by 10 feet, but it is found that, by the time they are six or seven years old, this is too close, and alternate trees have to be removed. Whether to plant wide at the beginning, or to plant closely and later on take out alternate trees, is an open question, and there is much to be said for both methods. The latter is the cheaper way as it reduces the cost of weeding and some rubber is obtained from the alternate trees before they are removed.

Clean weeding is the general rule in Southern India, or at least an attempt at it, and the constant scraping away of the top soil has in many places done much harm and held the trees back. In some places the use of cover crops such as *Centrosema* and *Erythrina* is understood and appreciated. The *Erythrina* is grown in rows between the rubber, and when it reaches a height of 3 or 4 feet it is topped and the suckers are bent over until the bushes touch one another, thus forming a dense cover under which no weeds can grow. After this the suckers are cut twice or three times a year and laid on the ground as a mulch. As the rubber grows up and closes in, the *Erythrina* becomes weak and struggling from want of light and it is then pulled up

On laterite soils deficient in humus this method is very beneficial. *Erythrina* leaves containing 1·4 % of Nitrogen as they fall and the sun-dried cuttings as much as 4·78 % of Nitrogen.

With regard to the use of manures, experiments are in progress, but no really reliable results have as yet been obtained. The result of the first year's experiments on one estate showed that a well balanced general manure increased the yield of seven year old trees by five ounces per tree on 138 tappings in the year.

Tapping.

The half herring-bone system of tapping, or some modification of it, is the one most generally adopted, and the one which has so far given the best results. One third or one quarter of the tree is operated on at a time. A vertical groove is first cut in the outer bark extending from a height of about six feet down to the ground. From this at intervals of about a foot oblique cuts are made sloping upwards at an angle of forty-five degrees on one side of the central channel if made on both sides of the central channel the system is known as full herring-bone. These slanting cuts are made deep enough to tap the inner bark and cut the latex cells, but not deep enough to touch and injure the cambium. This implies a great deal of skill on the part of the tapper, but the coolies soon learn to do this work quickly and well, the women being particularly skilled

From the lower side of each side-cut, a thin shaving is removed, usually every other day The latex runs down into the central channel and is collected at the bottom in a cup made of enamelled tin, or glass in some districts cocoanut shells are used as collecting cups, but they are not very easy to keep clean

A very large number of knives are on the market for performing this tapping operation, some being very simple and others very complicated. The knife most generally used in Southern India, is the *Berende*, but it is being realised more and more each year that it is the man behind the knife that counts, and the simpler the knife the better.

A good tapper keeps all his cuts parallel, and of the same length and depth, and takes off a very thin shaving of bark at each operation. It is only necessary to reopen the latex cells, so that the thinnest possible shaving should be removed each time in order not to waste bark. 16 or 18 cuts to the inch are usually made by a good tapper though 20 is the ideal to aim at.

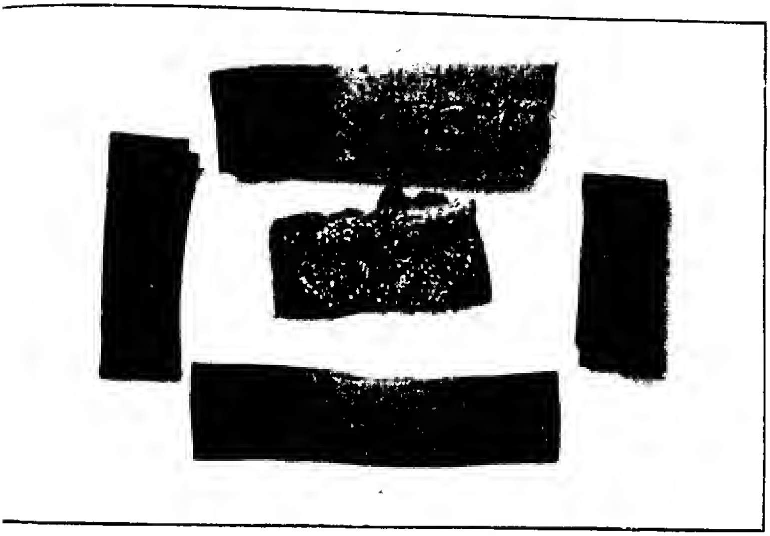
Other systems of tapping are under experiment, especially those in which the bark is not cut away but punctured instead with a tool called a 'pricker,' and also methods which are combinations of paring and pricking. The test of a good tapping system is that the cuts or punctures heal over rapidly and give renewed bark which can be easily tapped and which will give a good yield of latex. There is need for a great deal of experimental work in tapping methods, and it is doubtful whether the best method has as yet been discovered.

Manufacture.

The latex is collected from the cups into enamelled pails and carried to the factory. In this process and in all those to follow the utmost cleanliness is essential if a good class of rubber is to be made.

A rubber factory at which high grade rubber is being made has many attributes of a dairy, the milk like appearance of the latex adding to this illusion, as well as the precautions taken to ensure absolute cleanliness. One of two methods of manufacture is generally adopted. If the estate is young, and only a few trees are being tapped, and the supply of latex is in consequence small, the rubber is made in the form of biscuits or sheets. The latex is put into shallow round dishes, or oblong pans, and a certain quantity of Acetic Acid added to it. This is the coagulating agent most generally used, and after standing for some hours the rubber is found floating on the top of the dish in a white spongy clot. This is removed and washed, and rolled by hand or through a mangle, until clean. The biscuits are placed on racks in a warm room or an artificial drier and allowed to remain there until dry. The finished biscuits are

pale amber coloured and transparent and for this reason are popular on the market, for their purity and freedom from dirt can be judged by holding them to the light and looking through them.



1. W[illegible] R[illegible] 2. B[illegible] [illegible] VARIOUS GRADES OF CREPE.

On estates, however, where many trees are being tapped and a large volume of latex is being collected each day, the process of making biscuits occupies too much factory space and labour. Machinery must be installed to deal with large quantities of latex and wet rubber at a time. This machinery is usually driven by an oil engine but, on estates with large supplies of timber, water gas made from charcoal is found to be a cheaper source of energy than oil and a suction gas engine is used. The usual process of manufacture is as follows. The latex when it arrives from the field is strained into a centrifugal machine, the requisite amount of Acetic Acid added, and the whole centrifugalled until coagulation is complete. The resulting mass of spongy rubber is lifted out and the water in it squeezed out by passing it between rollers. It is next cut up into small pieces

called worms, by passing it through a special machine, and these are spread on trays and dried in a hot air chamber by artificial heat. The dry rubber is then passed through a crêping machine of some sort and washed and made into long lengths of any desired thickness and width. These are finally hung up to dry over wires stretched up and down a long room to which only red light is admitted. Finally the rubber is packed for shipment in standard boxes, which are planed quite smooth inside, so as to avoid the possibility of the rubber being contaminated with dust or splinters.

Smoking.

The rubber is sometimes smoked while drying. This is said to add to its strength and to enhance its value, but the methods adopted can hardly be considered satisfactory as yet. There is here a big field for experiment and research. The object is to imitate as far as possible the Para rubber as made on the Amazon, which still fetches the best prices. This is coagulated in the smoke of a fire and made in blocks, the latex being laid on in successive layers, and in all probability herein lies the secret of success and no process of smoking after coagulation can imitate this. In the light of recent experiments it is quite possible that Carbon dioxide and other gases in the smoke are the coagulants, and that the former might be used as a coagulant in the factory. A gaseous coagulant, which would leave no excess in the coagulated rubber to be washed out, would be a decided advantage, and it would be more easy in this case to force smoke through the coagulating latex at the same time. Devices of this nature are in use and are said to be giving good results, but they have not yet made their appearance in South India.

Conclusion.

Wherever Hevea rubber is grown it presents many problems to be solved by both planter and scientist. No finality has been reached as regards even methods of preparation and here alone there is considerable scope for research work.

In Southern India the rubber suffers from few diseases, and these are easily controllable, while the soil and climate are very suited to its rapid growth, seven-year old trees attaining a girth of twenty three inches and more at three feet from the ground. With regard to yield, nine-year old trees have given 315 pounds of rubber per acre, and seven-year old trees 138 pounds per acre.

Hence the industry should have a great future before it, if it is conducted on up-to-date and scientific lines. Unfortunately, however, there is at present little tendency towards progress, and there is practically no co-operation among rubber planters, and nothing is being done to provide for research work of a scientific nature being undertaken. The tendency is rather to wait for discoveries to be made in other rubber-growing countries and to follow rather than to lead.

POTATO MOTH IN BENGAL.

By E. J. Woodhouse, M.A., F.L.S.,

Economic Botanist to the Government of Bengal.

The potato moth (Phthorimaea operculella) has not been found to injure the growing plant in Bengal, and very few insects can be found in the field, but the bulk of the damage is done to the heaps of potatoes lying in the godowns during April and May, so that it is in the godown that the pest must be fought. The pest first appeared in Dinapore in 1907, and in 1908 it spread to Bankipore, Patna and the neighbourhood. In 1909 the pest was reported to me and steps were taken to deal with it. A godown was rented by the Divisional Agricultural Association, and a demonstration of the methods of storing recommended by the Imperial Entomologist was arranged. The potatoes were stored under sand or *neem* leaves alone, or under sand or *neem* leaves after treatment with phenyle and also by the country method in baskets. At the end of the storing period it was found that storing in sand had proved most successful, and out of four maunds stored two and a half maunds (62 per cent.) were removed at the end of the storing period. When the disease was at its worst a local cultivator stated that he had been inspired by a saint to invent two remedies, which were found by the Agricultural Chemist to consist of phenyle and napthalene adulterated with red oxide of iron. These specifics were tried, but out of one maund of potatoes treated with them only three seers were

(1) T. H. Maxwell Lefroy & Evans. Experiments on the storing of the potato. Agricultural Journal of India, Vol. V, Part 1.

preserved until the sowing time. During this year no cultivator was persuaded to store his potatoes under sand, though leaflets had been issued recommending this practice.

In 1910 arrangements were made to carry out further demonstrations at Patna on a larger scale, and it was decided, in consultation with the Imperial Entomologist, to store half the tubers under sand alone, and half under sand after treatment with crude oil emulsion. In one godown twelve and a half maunds of potatoes were stored under sand in one room and a similar quantity was stored in a second room under sand after treatment with a 10 : 1 solution of crude oil emulsion for 5 minutes, similar arrangements being made for storing the potatoes by these methods in two rooms in the second godown. The potatoes were stored on April 23 to 26 and were picked over some fourteen times before the tubers were weighed and sold off on September 21. Out of twenty five maunds of potatoes stored under sand thirteen maunds four and a half seers (46 per cent.) were obtained at the end of the storing period, whereas the same quantity of tubers treated with crude oil emulsion gave only three maunds twenty five and three-quarter seers (11·5 per cent.). While the potatoes stored under sand came through the rains very satisfactorily, the duplicate lots treated with crude oil emulsion rotted very badly during the first month of storage. The rotting was probably due to the emulsion purchased from Calcutta having been badly prepared, but in any case the demonstration proved that it is sufficient to store the tubers under dry sand without any other treatment, and that a good profit can be made by storing potatoes in this way. During the season six cultivators at Patna were persuaded to try the methods of storing recommended, and one hundred and twenty-two maunds of potatoes were stored successfully under sand alone, while the seventy-four maunds of tubers stored under sand after treatment with crude oil emulsion gave bad results.[2] In the meantime the pest was reported from Muzaffarpur in October 1910.

(2) Further details of the work done in 1910 will be found in Bengal Quarterly Journal, Vol. IV, No. 4.

In 1911 the position altered considerably for the worse in that the pest was reported from the following new districts Champaran, Saran, Bhagalpur, Santhal Perganas, Burdwan, Hazaribagh and Angul, but in most cases the reports were not received sufficiently early in the season to enable anything to be done except at Bhagalpur. At Bhagalpur a large quantity of potatoes were thrown away in the panic following the appearance of the pest. An attempt was made by the Municipality to destroy all diseased potatoes in the market, which frightened the cultivators and made them conceal from us the fact that they were storing potatoes. As a result of this, the first season's work, only three cultivators stored thirty maunds of potatoes under sand in Bhagalpur, and at Sidoon four cultivators stored fifty-four maunds.

At Patna the demonstration work was continued in 1911 on the same lines, except that the method of dipping the tubers in crude oil emulsion before storing them in sand was abandoned. Out of twenty-five maunds of early-sown *Naika chaurasi* potatoes, grown on unirrigated low lands, which had been stored on 22nd March in one large heap, fifteen maunds twenty-four and a half seers (62·5 per cent.) were removed on September 23. A second lot of twenty-five maunds of later *Dasi* potatoes, grown as a second crop on high lands under irrigation, was stored in smaller heaps in two godowns on April 4, and twelve maunds (48 per cent.) were sold off on September 23. A summary of the results of these demonstrations is given in Appendix I. In addition to the above demonstration work special attention was paid to introducing this method among the local cultivators. In the previous year a selected cultivator had been employed to watch the stored potatoes, and this man, who thoroughly understood our method of treating the potatoes, was again employed this year, and was offered a commission at the rate of four annas for the first ten maunds stored by each cultivator, and one anna for each subsequent ten maunds up to a maximum of fifty maunds. As a result of his efforts two hundred cultivators stored eight

thousand four hundred and thirty one maunds of potatoes under sand.[3]

In 1912 it is probable that the pest will spread further throughout the province and will do an increased amount of damage in all districts where it has appeared unless the method of storing under sand is universally adopted. The damage done by the pest can be gauged by the fact that the exports of potatoes from Patna have decreased from two hundred and seventy-seven thousand maunds in 1908 to fifty-four thousand in 1911 (*vide* Appendix II), while a considerable area of land has gone out of potato cultivation. The question of prohibiting the export of potatoes from affected areas was at one time considered, but effective isolation of the areas was found to be quite impossible as the pest may either be carried in small parcels of potatoes sent out for seed or in large consignments despatched for use as vegetables. The only hope of dealing with the pest appears to lie in the adoption of the sand method of storage, and demonstrations of this method are being organized wherever the pest appears.

As regards the financial side of storing under sand, it can be shown that very good profits are obtained in affected areas where the price of potatoes is abnormally high. Two Balance Sheets are appended (Appendix III) for the years 1910 and 1911, and from them it will be seen that a good profit was made in spite of the fact that it was necessary to rent a godown and employ a chowkidar for the small quantity of tubers stored. In the case of a cultivator who stored his own potatoes in his own house the cost of sand, *chattais* and picking charges would not exceed eight annas per maund stored. It should be noted that Lefroy and Evans[4] give the cost of storage as likely not to exceed one anna per maund, but in the experiments in the Central Provinces the potatoes were picked over two or three times only during the wet season. At Patna in our demonstrations as many as 15 pickings were given as the sand

[3] Further details of the work done in 1911 will be found in Bengal Quarterly Journal, Vol. V, No. 3.

became wet and the tubers rotted quickly in the rains. The cultivators at Patna avoid the expense of frequent pickings in the rains by uncovering their tubers and only covering them up again when the moth begins to do damage. This works satisfactorily only if the numbers of the moths have been kept down by keeping the potatoes covered in April and May. In localities where the pest is doing serious damage there is no doubt that large profits can be made by storing potatoes under sand in spite of the cost of storage, as the cost of potatoes at harvest time is only about one rupee per maund, but may rise up to as much as fourteen to twenty rupees per maund, by the next sowing season.

The following precautions must be taken in storing potatoes under sand. (1) The godown selected for storing the potatoes must have a good watertight roof and walls, and should be cool in the hot weather. It should be clean and should not provide hiding places for the moths. The floor should be dry and well raised above the ground-level, so that it will remain dry in the rainy season. If it is likely to become at all moist, *charcoal* should be spread over it. (2) The potatoes should be picked over before they are stored to make certain that none of them are rotten or contain insects. They should be in good condition. (3) If the godown is perfectly dry and the potatoes are in good condition and have been properly picked over, the heaps of potatoes, which should not be higher than eighteen inches, may be covered with clean dry river sand until no tubers are exposed. The sand must be dry. The heaps must be picked over at intervals and all rotten tubers removed. The rejected tubers should be burnt or buried. At the first picking the pupæ should be sieved out of the sand, but subsequently this will not be necessary. During the rains the tubers should be picked over very frequently, or they may be left exposed if the moth is not in evidence, but they should be covered up again as soon as any damage becomes apparent. Care should be taken to prevent leakage of water on to the heaps in the rains, and the sand should be dried when possible.

Summary.

The potato moth is first known to have appeared in Bengal in 1907 and is now spreading rapidly over the province. The method of storing potatoes under sand recommended by the Imperial Entomologist is the only satisfactory remedy, and has been proved to be a paying one at Patna during 1910 and 1911. This method is being demonstrated wherever the pest appears in Bengal, and in the second year of the demonstration the cultivator in charge of the previous year's demonstration is given a commission on the number of local cultivators whom he persuades to adopt this method of storage.—

Appendix I.

Results of Potato Storage Demonstrations at Patna.

Experiment.	Weight stored.	Weight removed as seed.	Percentage removed.	Weight left at end.	Percentage left at end.	Percentage amount of drying by difference.
1909.	Mds. S.	Mds. S.		Mds. S.		
Tubers stored under sand and napthalene	4 0			2 20	62·0	
1910.						
Godown A. Sand and naphthalene ...	12 20	3 34	30·8	6 9½	49·9	19·3
Godown B. Do. do. ...	12 20	3 1	24·2	6 35	55·0	20·8
Five cultivators' godowns in sand	122 0			56 0	46·0	..
Godown C. Sand after crude oil emulsion ...	12 20	7 30	62·8	2 3½	16·8	20·6
Godown D. Sand after crude oil emulsion ...	12 20	7 33½	62·9	1 22½	12·5	24·9
Five cultivators' godowns in sand after crude oil emulsion	74 0			4 10	5·7	
1911.						
Mds stored under sand alone						
Godown 1. *Naika Chowmat*	25 0	5 16½	21·7	15 24½	62·5	15·8
Do. 2. *Dohan*	12 20	3 8½	25·7	5 37½	47·4	26·9
Do. 3. ,,	12 20	3 ½	24·0	6 2½	48·5	27·5

APPENDIX II.

Statement of Potato traffic showing amount of Potatoes despatched from Patna during the years 1908-1911.

MONTH.	QUANTITY DESPATCHED DURING THE YEAR (IN MAUNDS).			
	1908.	1909.	1910.	1911.
January ...	6,881	7,100	4,100	2,880
February	3,068	4,781	2,725	3,897
March ...	10,305	2,880	3,599	9,128
April	27,520	16,150	20,754	11,882
May ...	65,502	18,062	16,588	6,67[illegible]
June	60,950	20,537	5,455	[illegible]
July	25,398	9,537	2,987	69[illegible]
August	14,347	2,851	721	271
September ...	6,156	5,180	1,663	[illegible],797
October	3,062	13,571	1,917	8,271
November	13,174	10,378	5,373	2,882
December	22,101	12,413	10,258	3,878
Total weight despatched in the year	277,383	125,693	78,710	54,[illegible]80

APPENDIX III.

Balance Sheet of Demonstrations of Potato Storage under Sand at Patna.

1910.—DEMONSTRATION.

	Rs.	A.	P.		Rs.	A.	P.
1. To cost of 50 maunds potatoes	61	4	0	By sale of 24 maunds 17 seers medium tubers at Rs. 6 8 per md.	1[illegible]	[illegible]	[illegible]
2. To rent of house	15	5	0				
3. To cost of sand	2	0	0				
4. To miscellaneous materials	10	11	9	By sale of 1 md. 32 seers small tubers at Rs. 8 per maund	11	[illegible]	[illegible]
5. To coolies for picking, etc.	15	2	0				
6. To chowkidar (for 1 month	2	6	0				
By Balance to Profit	68	11	3	By sale of bamboo baskets ...	[illegible]	[illegible]	[illegible]
	175	2	[illegible]		175		

Net profit per maund put into storage, Re. 1 6.
... (excluding rent of house and pay of Chowkidar), Re. 1 11 6.

N. B.—The figures for the potatoes sold have been calculated for 50 mds. of potatoes stored under sand. The figures for 25 mds. of tubers treated with crude oil emulsion [illegible] been omitted, and the figures for the 25 mds. of tubers stored under sand have [illegible] doubled. This makes these figures comparable with those obtained in 1911.

1911—Demonstration.

		Rs.	A.	P.		Rs.	A.	P.
1.	To cost of 50 maunds potatoes	65	5	6	By sale of 23 mds. 1½ seers medium tubers at Rs. 7 per maund	161	12	6
2.	To rent and repairs of house	17	12	9				
3.	To cost of sand	3	13	0				
4.	To miscellaneous materials ...	3	12	6				
5.	To coolies for picking, etc.	12	8	9				
6.	To chowkidar at Rs. 6 per month	37	15	0	By sale of 4 mds. 10 seers small tubers at Rs. 8 per maund ..	34	0	0
	By Balance to Profit	54	9	0				
		195	12	6		195	12	6

Net profit per maund put into storage, Re. 1-4.
" " (excluding rent of house and pay of chowkidar), Rs. 2-3-3.

N.B. It was found necessary for Departmental reasons to sell off the tubers at Rs. 7 on September 23, but if they had been kept in store for another month they could have been sold at Rs. 10 per maund on October 7 or Rs. 14 on October 20.

ROWS OF SPOTS ON THE LEAVES OF PALMYRA PALMS.

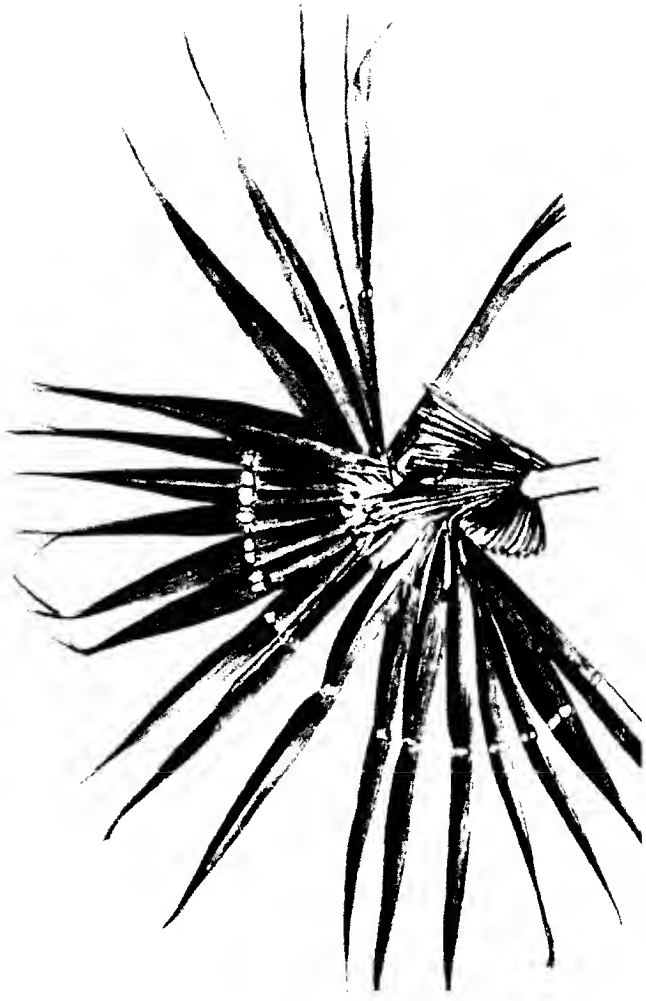
CAUSED BY THE BUD ROT FUNGUS, *Pythium Palmivorum, Butl*

By W. McRae, M.A., B.Sc., F.L.S.,

Mycologist to the Government of Madras

As usually seen in the Godavery and Kistna deltas the crown of a palmyra palm consists on the lower part of a number of leaf-sheaths or leaf-bases from which the green leaf-blades have been cut and above of a number of expanded and expanding green leaves. These leaf-bases are the oldest foliar parts on the palm. The lowest ones and the outer exposed parts of the others are hard and fibrous in texture and brown or almost black in colour. These parts are dead. The inner parts are light yellow in colour and are living. The number of these leaf sheaths varies considerably. There may be up to 40 or more. They are used for fuel, and a fibre is extracted from them for local use, so they are not allowed to remain very long on the tree.

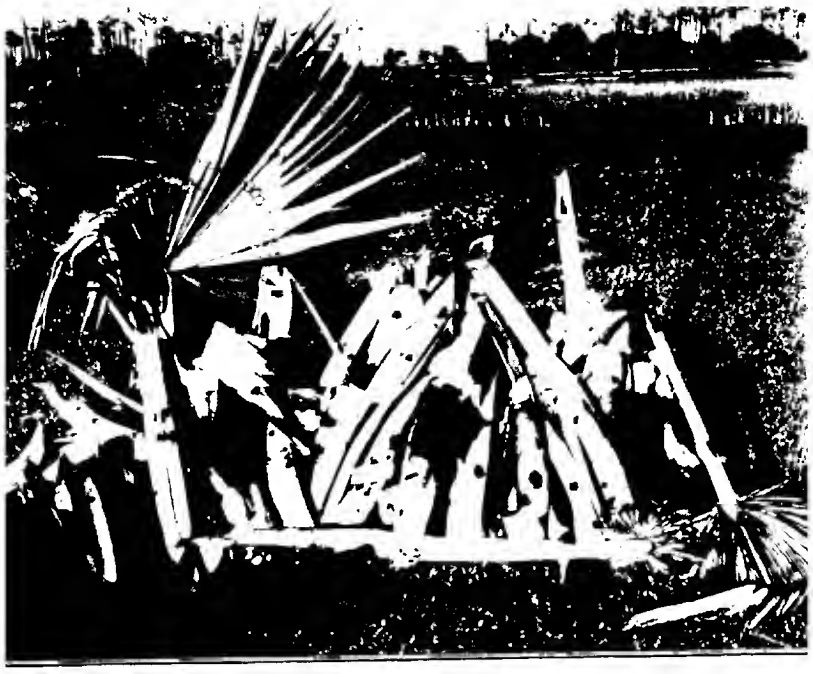
Each leaf-base partially encircles the stem, and all the leaf bases, closely fitting one above another, form a sheath round the upper part of the trunk, on which is the inner bud of creamy yellow, developing leaves, compactly pressed together and in various stages of development, down to the papilla of the growing-point. The latter is in the centre of the bud on the topmost part of the trunk. The length of the leaf-sheath varies from one to two and a half feet, and this represents the distance by which the growing-point is sunk below the place where the expanding leaves push out of the bud into the open air. The growing-point thus sunk is very well protected. As each palm has but one growing-point, the advantages of such an arrangement are apparent.

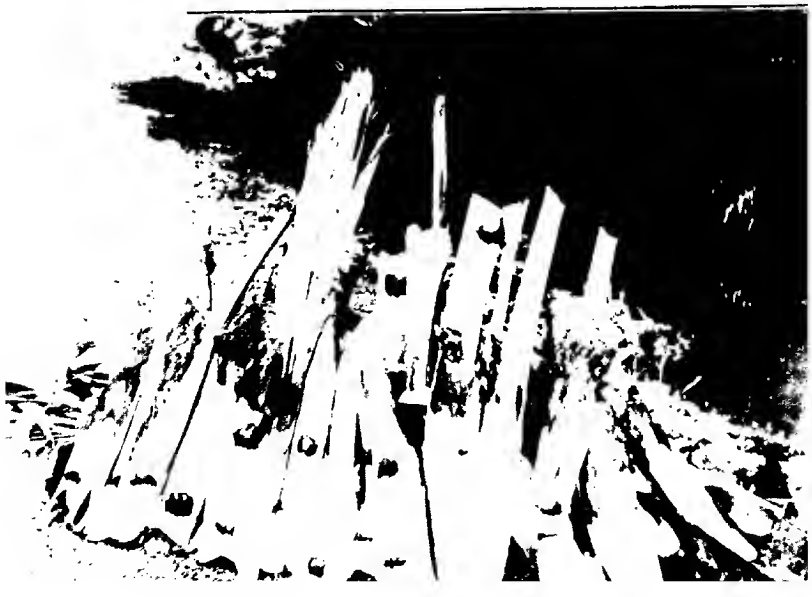


2. The parts of the palmyra most susceptible to the attack of the bud rot fungus (Pythium palmivorum) are the succulent yellow parts of the leaf-sheaths (Plates XXXVI and XXXVII *b*), and these are often exposed when the lower leaf-sheaths are being cut off for fuel or fibre. The fungus begins from outside and gradually eats its way inwards through successive leaf-sheaths. The point of attack of the first one may be either at a lower or a higher level in the crown. If the former, the fungus eats its way inwards till it reaches the region of the growing point, where all the soft succulent tissue becomes diseased, including the youngest leaves and the growing-point, which die (Plate XXXV *b*). After the growing-point is killed no new leaves are formed and the palm is doomed. The central expanding leaves are pale yellow in colour and never become green; the green leaves wither one by one and fall off, till at last nothing is left but a bare pole. In the course of the operations now in progress it is the crowns of such palms that are being cut off and burned, at the stage when the central expanding leaves are pale yellow (Plate XXXIII).[1]

3. When, however, the fungus begins its attack well above the level of the growing point, it eats its way inwards through the leaf-sheaths till it reaches the young expanding leaves. It attacks their tissue, boring through them exactly as it does through the leaf-sheaths. In the bud the blade of each of these young leaves is folded on itself exactly like in a lady's fan. The fungus goes straight through the folded leaf-blade making a series of spots one against the other in the closely folded segments of the leaf. As the leaf is developing actively it soon pushes out into the air and expands. The spots then appear on the leaf-blade as a series of spots all in a row (Plates XXXIV and XXXV *c*). They vary in size from ½ to 6 inches in longitudinal diameter, while their transverse diameter is, of course, limited by the breadth of the segments of the leaf (about 1½ inches). In the centre they are pale yellow in colour and have a brown border, but they become much darker with age. They show up well against the

(1) See also [illegible] Vol. I, pp. 303–40 [illegible] 1906, and [illegible] Bot. Series, Vol. III, No. V, 1910, by Dr. E. [illegible]





position to be distributed by the wind: they are on the highest leaves well above the surrounding leaves of the palm.

As a palmyra produces approximately one leaf a month[2] it follows that a palm, in which the course of the disease runs as above, produces a monthly crop of spores extending over a period of from 14 months to 3½ years, and produces them in the most favourable position for dissemination by wind to other palms.

6. The relative number of infected palmyras that live for a long time producing spotted leaves is small, though it seems much higher now than formerly. In the village of Vunagatla in Kistna District the number of palmyras that have become diseased (till March 1912) is 154, of which 28 have spotted leaves, that is 18 per cent. In Panditavillur 208 palmyras have become diseased, of which 17 have spotted leaves, that is, 8 per cent. In the village of Pithapuram on the boundary of the infected area to the north is a small, isolated, recently infected area which is two miles from the other infected villages. Here 176 palmyras have become diseased and 6 of them have spotted leaves, that is 3·4 per cent. The average for the district is, I consider, slightly below this last figure. During the operations since the end of 1908 in Godavari District and the beginning of 1910 in Kistna District the dead palms have been fairly regularly cut down over the whole of the infected area. The living diseased palms with spotted leaves have always been left standing, because of the strong objection of the owners to cut living palms. Now their number strikes an observer. There must be several hundreds in the infected area and they are acting a part in the distribution of the disease.

7. To see if they would recover after treatment, experiments have been made with some of them. The spotted leaves were

(2) [illegible] leaves produced by [illegible] palmyras during the last year the [illegible] have to be continued for several [illegible] before reliable numbers can be had.

removed and all the diseased leaf-sheaths were cut off close to the trunk and three more that did not appear to the naked eye to be infected. In most cases the treatment was drastic, the leaf-sheaths of all expanded leaves had to be cut off, leaving only the central bud of expanding leaves. In two cases even this had to be cut off because of the danger of the wind blowing off the long bud of leaves supported unstably by its delicate, somewhat brittle tissue. A small stump of leaf tissue about 4 inches broad and 6 inches high was left covering the growing point. This set of experiments was done during the monsoon when the sky is often cloudy and the exposed tops of the palms were less likely to be desiccated. All of the palms survived and put forth new crowns of leaves (Plate XXXVII *a* 1, 2, 3). Two of them became diseased and were cut down, and one has diseased spotted leaves. The other 6 are still healthy. The experiments have been going about 20 months. Three palmyras similarly treated during the rainless period of the year (March 1913) recovered and grew healthy crowns, so that it is quite possible for the tops of palms cut in this way to escape desiccation in the hot months. In cutting off the diseased part of the crown the outer undeveloped leaves of the small stump of tissue left on top of the trunk have their leaf-blades sheared off. When the crown develops those mutilated leaves grow out as seen in Plate XXXVII, figures *a* 1, 2, 3. The next few leaves are stunted, but the succeeding ones gradually increase in size to the normal.

8. During my touring I have kept a look out for cases where, in the course of the operations, the crown has been cut off a diseased palmyra and subsequently a new crown has been produced. I have dissected about a dozen of them and have found in every case that the new crown arose from the original growing point which had evidently escaped injury when the crown was cut off. The new crowns of several, cut 18 months ago in Polbekurru village, have become almost as large as the original crown, and that of one in Cherukuvada, cut 2 years ago, is now larger than its uncut neighbours of about the same height. It has 31 green leaves.

9. A large number of these new crowns subsequently succumb to the disease. This occurs in most cases because all the diseased tissue had not been removed with the crown. This is easy to understand, for, when a diseased spot occurs low down on a leaf-sheath, near the point of insertion on the stem, it is difficult to remove all the infected tissue and if the disease has passed a little way into the soft tissue of the stem, as it sometimes does, it is well nigh impossible to have it cut out completely. The palms are usually high, and the work must necessarily be done by the ordinary toddy-tapper, who, while cutting off the crown, works in a rough and ready manner.

10. Cutting off the spotted green leaf-blades only is of no use. Doing that does not remove the disease from the palm nor does it even prevent the leaves from shedding spores. The fungus is still left in the leaf sheaths where it attacks young leaves and again produces spots as well as gradually eats its way towards the growing-point. The spotted leaves are usually noticed only after they have been expanded for some time: then the spots are dry and have passed the spore-bearing stage. By the time a palm has produced spotted leaves, the fungus within the sheath of leaf bases has got a good hold and is actually working within the bud though well above the growing-point. The delay in discovering that such palms are diseased is due to the fact that from the moment of infection by the fungus till the time when the palm produces its first spotted leaves, which in this case is the first outward symptom of disease, a period of several months intervenes. It is impossible to get evidence of disease earlier except by cutting off the leaf-sheaths while the palm is still quite healthy looking, and that, of course, is quite impracticable as a means of discovering the disease in its early stages.

11. It has been shown that cutting off all the diseased leaf-sheaths and leaf-blades from a diseased palmyra whose growing-point is yet intact, enables it to recover its healthy condition. But the difficulty of inducing ryots and tappers to do this so thoroughly as to ensure good results is great. It means

that many leaf-sheaths have to be cut off before all the infected ones are removed as has been mentioned in para. 7 above. In many cases every green leaf has to be removed. Yet neither owner nor tapper would have fortitude enough to go on removing leaf-sheaths till all the diseased ones had been cut off. He would stop too soon, and the fungus which was left would continue to act on the palm till it killed it. Money spent in doing this kind of thing would be wasted.

12. These diseased palmyras with spotted leaves act as centres of infection producing regular crops of spores for a long time and are spreading infection to other palms, thus retarding the attainment of the object for which the operations were initiated. They ought to be dealt with in the course of the operations. In the circumstances, cutting off and burning their crowns is the only really satisfactory way at present of dealing with them. As ryots and tappers become more familiar with the idea of a fungus disease and realise that the spots contain the disease and that the disease is infectious, they may eventually be able to treat these cases in the proper way with hope of success.

EXPLANATION OF PLATES.

PLATE XXXIII.—Two palmyra palms attacked by the bud rot fungus, *Pythium palmivorum, But*.

The one on the right shows the central expanding leaves becoming yellow, the stage at which the disease first becomes apparent. That on the left gives the appearance 3 or 4 months later.

The arrow marks the level of the growing point.

PLATE XXXIV.—Leaf of a palmyra showing a row of spots and the lower part almost completely destroyed by the fungus. ½ natural size.

PLATE XXXV.—Inner part of the bud (*a*) of a healthy and (*b*) of a diseased palmyra.

The sunken spots are shown well.

(*c*) Part of a row of spots on a leaf of a palmyra.

PLATE XXXVI.—Two heaps of leaf-sheaths from diseased palmyras that are to be burned.

In (*a*) a leaf on the left has 3 rows of spots on its green portion. The blades of all 3 leaves shown have been more or less destroyed by the fungus. Spots occur at different levels on the leaf sheaths and leaf stalks.

In (*b*) the upright leaf has a spot at the junction of the stalk and the blade. This was the expanding leaf which had the yellow appearance that led to the detection of disease in the palm.

PLATE XXXVII.—(*a*) Palms from which the diseased crowns had been cut and on which subsequently new crowns developed.

(1) early stage, (2) later stage, (3) still later stage on the topmost leaf of which a row of diseased spots appeared. This palm died afterwards and was cut down.

(*b*) Part of the crown of a palmyra a few days after the expanding leaves appeared yellow but the expanded leaves were still green. The spots on the leaf-sheath are shown well.

LOCAL BODIES AS AGENTS IN AGRICULTURAL IMPROVEMENT

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In the organisation of agricultural advance in any country or under any conditions whatever, it has ultimately had to be recognised that the bulk of the work must be done by the farmers or cultivators themselves. A government, an agricultural department, a body of state servants, may point the way, may suggest the lines, but until the people can be interested and become enthusiasts themselves, the advance will be slow, will be looked upon with suspicion, and will be more apparent than real. This condition of things has prevailed in almost every country where changes have taken place as the result of the action of a state department. It has been, perhaps, more strikingly the case in the United States of America, where the state action has been greater than anywhere else, but where, until comparatively recently, most farmers looked on the work of Government with amused interest and little more.

It is this fact that has made most of the far seeing leaders in the development of agricultural departments in India very insistent on the necessity for developing local bodies composed of cultivators themselves or of others interested in agriculture who should be committed to advanced methods, should show them in action on their own land, should act as local emissaries of whatever in changed methods has been proved to be good. How to bring about the formation of vigorous local bodies for this purpose has been a matter of great difference of opinion. But that such bodies must exist, that there must be local centres

doing what an agricultural department itself could never hope to do,—on this point, there has been little difference of opinion.

The results of endeavours to organise such local bodies have, however, as would be expected, been extremely varied. In the Central Provinces, on the one hand, they have become, and tend to become even more, the main link between the agricultural department and its investigators, and the people. On the other hand, in Madras they have been, as hitherto organised and carried on, of very questionable value, and it has been recommended that, in their present form, they may well be wound up. In other provinces, very varying success has been attained. But it is impossible not to recognise that there has been a great amount of local energy, public spirit, and enthusiasm devoted to these associations even where they have apparently been of the least value,—and this, put into the right channels, will be of very great assistance in development in coming days.

The amount of experience gained in India has now been, I think, sufficiently great to warrant a short statement of the conditions which have led to success in the organisation of local bodies for popularising and encouraging genuine agricultural improvements. This matter was, in fact, considered by a strong committee at the last meeting of the Board of Agriculture, and the present article is, in essence, a summary of their report.

India stands in such a very special position in respect to the character of the vast mass of its cultivators and the greater part of its agriculture that it might be, and has indeed been often asked by men of small or limited experience, whether under the special circumstances of the case, it is either necessary or advisable to encourage such local bodies as we are discussing. Cannot the Agricultural Department communicate directly with the cultivators? Is not such communication with and help giving to individuals of equal value to work done by and through a local association of any kind whatever? While this *can* be done, while it is *possible* to deal direct with every cultivator in the districts, it is becoming more and more clear that this is not

generally the best or most economical way of proceeding. A local organised body is a far more efficient agent for the introduction of improvements than the few officers of the agricultural department, working individually, can ever be, for, being a body of local men, it carries considerable local influence if composed of the right people, the members can and do mutually encourage one another, while its educative value in combined work and co-operative effort is, if properly organised, greater than can be realised. Even if the same end can be gained, so far as the introduction of an improvement is concerned without a local association, a better final result can often be attained if a local body, as such, takes a share in the matter; as tending to increase the co-operative spirit of the people and hence the likelihood of permanent advance.

Success with such associations can, however, only be reached by following certain lines which can now be laid down with some approach to certainty. However organised, it is necessary that (1) every local association should have a definite work to do, and the members should feel responsibility for taking a share in it. In the past it has not been at all unusual for an association to fail because the members have not been responsible for any work. Again the first question by a local body, however got together, is "What shall we do?" Unless the organisers of every single association, generally the agricultural department, have definite work which can be placed in the hands of the members, within their capacity, it is extremely unwise to attempt any organisation whatever.

(2) A local association should be composed of men who are really interested,—and practically interested,—in agricultural improvements in the area in question. Associations have perhaps more often failed on account of the neglect of this matter than for any other reason. The members had but an academical interest in the subject, became members because of social or other reasons, and did not take its work seriously.

(3) The work of a local association should be regularly inspected, examined, criticised, and the association called together. Great stress must be laid on this matter, and it is probable, for

instance, that a considerable part of the increasing efficiency of the system in the Central Provinces has been due to the care which is taken in this matter. It undoubtedly involves on the part of the agricultural department (or a central body of some sort) a considerable expense for inspecting officers, but without this, it may be stated with certainty that the result will not be a success except in rare cases.

(4) The members of a local association must, even apart from inspection, be made to feel that the agricultural department is interested in them and their work. It is wonderful how regular correspondence, prompt attention, and general evidences of interest and support encourage both the individuals and the associations of which they are members. If local agricultural associations are to be a success, this must be arranged for at any cost.

With these principles accepted and in full operation, there is every chance of success: without these there is very little likelihood of local associations being or doing what they are capable of. The actual type of association may be very different, and very different types of association have succeeded, but success in every case involves a frank recognition of the principles laid down. And it is hence of the highest importance that associations should not be encouraged or organised unless these points can be arranged for. In time past there has been in some cases a tendency to encourage or form associations when there were no definite lines of work to take up: when the men of whom they were composed were not men really interested: when no regular inspection could be arranged for, and when they were left for long months without any attention. It is not wonderful that such associations died or became moribund.

Passing on from general principles to successful applications, it may be noted that success has been attained by following several lines. In the Central Provinces, where perhaps the most valuable work has been done, the associations are bodies composed of nominees, limited in number, of the district officers for

each district. These, say for instance, to the number of thirty, are called together to a convenient centre, appoint a secretary, and are met by a senior officer of the agricultural department, usually the Deputy Director, who has a number of pieces of work suitable for their district, ready to suggest to the members to take up. These are not experiments, but consist in carrying out some introduction of new seed, or the demonstration of better methods of cultivation, and the like, in using their land as a seed farm, in distributing sulphate of copper for treating *linseed*, in acting as agent for ploughs, or in making arrangements for marketing and similar things. Each man is then supplied at once with the material he needs, and thereafter, is visited by an assistant once a month, and by the superintendent of the farm in that circle several times a year. Six months later all the members meet again the Deputy Commissioner is in the chair'; the Deputy Director is again present the work done is discussed, causes of failures made out, accounts of success recorded, and a new lot of work arranged for, for the ensuing period. Once a year, the members of all the district associations in a tract are called and meet at a common centre, generally a farm of the agricultural department, when experiences can be discussed among a larger collection of cultivators, selected outsiders being invited. All the proceedings, in these larger meetings, as well as in the district associations, are in the vernacular.

Over and above the points already insisted on, the success in this case may be attributed to the careful selection and nomination of members by the local authorities, to the small number of members who thus esteem membership an honour and to the lines of work being drawn up and carefully arranged *before hand* by the agricultural department.

The committee of the Board of Agriculture whose report is being summarised did not wish to suggest that the method of organisation just described is the only one which will succeed or which is even the best one under all conditions. It is possible perhaps even probable, that this type of organisation is most

suitable where the type of agriculture is backward or at any rate where there are large numbers of fairly obvious improvements capable of giving large and immediate results. In other cases it may be more advisable to have other units than a district, sometimes even as small as a village. It may (and the method has been successful in parts of Bombay) be wise to have much more independent bodies than those of the Central Provinces. It may be advisable to have a regular hierarchy of associations from those representing a very small area to one representing a whole province, and so on for many other variations which can only be determined locally.

But, however organised, the principles which have been laid down are essential. The time is now past when the agricultural associations can be created in every district in a province heedless as to whether there is work for them or whether they can be instructed and encouraged. If there is work laid down for each association and its members to do: if they are composed really of the men to whom agriculture is a vital interest: if they can be regularly inspected and meetings held: and if the association and its members can be made to feel that the agricultural department or some central body is continually interesting itself in the work going on and ready to give assistance, then it is almost certain that, provided the local circumstances are properly taken into account, a local body will be created of extreme value for the development of the industry.

LITCHI LEAF CURL.

By C. S. Misra, B.A.,

First Assistant to the Imperial Entomologist.

The curling of the leaves of the Litchi (Nephelium litchi Camb.) is caused by a whitish mite that lives amongst the hairs of the velvety growth on the lower surface of leaves. It is so small that it cannot be seen with the naked eye. It usually lives at the base of hairs and punctures the tissues of the leaf with its stout, pointed rostrum or beak and sucks the juice, with the result that the leaves wither prematurely and the growth of the plant is stopped. A brownish velvety growth on the lower surface of leaves is a characteristic sign of the presence of the pest, and is a peculiar proliferation of the epidermal tissues caused by myriads of mites living amongst the hairs. The infested leaves either curl over apically or at the sides forming compact cylinders. In cases of light attacks deep excavated pits lined throughout with brownish velvety pubescence are found on the leaves, and when these coalesce the leaves double over forming hollow cylinders. When the leaves begin to wither the mites leave them and establish themselves on the lower surface of young succulent leaves. At this time their upward progress on an infested tree can be distinctly traced.

In the majority of cases in young vigorously growing trees the attack generally begins from below and gradually extends upwards. The old infested leaves either fall off or remain attached to the branches, their lower surfaces being thickly covered with a chocolate brown velvety pubescence. In freshly attacked leaves the colour of the velvety growth is light whitish-brown.

PLATE XXXVIII.

AN INFESTED [illegible] THE [illegible]

The mites usually remain at the base of the hairs, and in a freshly plucked leaf it is not easy to detect their presence. Their examination is, however, facilitated by putting the leaf in a shallow saucer containing water for a day or two. The mites then come up the surface and can then be readily seen under the microscope. While at the base of the hairs, their chief function is to lacerate the tissues and suck the sap, with the result that the leaves are unable to respond to the heavy drain on them, and wither prematurely.

Fig. [illegible] After Bald.

MITE (*Eriophyes litchi*) ON UNDER SURFACE OF LEAF IN SITU.

The mites then leave such leaves and disperse themselves in quest of fresh leaves. At this time, as already mentioned, their upward progress can be distinctly traced on the infested trees. Such an exodus generally begins by the beginning of May and reaches its climax by the middle of July when a large number of litchi trees in a grove are generally seen to be affected. Young plants in nurseries and pots are most liable to attack.

The presence of the mites on the young plants is decidedly ominous and is the cause of loss of many a promising seedling. If once firmly established it is not easy to dislodge the mites

unless prompt measures are taken as recommended below. Old trees seem to escape with a light attack and have not been seen to suffer so much from the ravages of the pest as young, vigorously growing plants eight to ten years old.

Hitherto the mite has been known from Assam and Tirhoot but now with facilities for transport it is spreading fast in localities which have hitherto remained immune. It is especially bad in Tirhoot and has been lately reported by the Superintendent Raj Gardens, Durbhanga. Reports have also been received from the Managers of the Bamgaon and the Langla tea estates in Assam. The manager of the former estate, while forwarding specimens for identification and advice, wrote "I am sending by to-day's parcel post a specimen of a blight that has destroyed a large number of litchi trees in the district." More recently specimens of the blight have been received from Jalpaiguri (Assam), Champaran and Birowli (near Pusa) in Tirhoot, and Ranchi (Bihar), while it has also been seen to a very limited extent at Bankipore, Arrah, Benares, Lucknow, Shahjahanpore and Saharanpore. In the latter places only a few leaves of isolated trees were found affected, while in Tirhoot it was especially bad last year and was the cause of a poor crop.

The mite that produces the brownish velvety pubescence on the lower surface of leaves is a species of Eriophyes belonging to the order Acarina, class Arachnida (Mites). It is a small vermiform, four-legged animal, one-fifteenth of a millimetre to three-hundred and seventy-fifth of an inch) long, whitish in colour. The head which is united with the thorax (cephalothorax) is slightly bent downwards, and terminates in a blunt snout-like projection. The mouthparts consist of a pair of fine jaws (mandibles) and a pair of maxillary palpi which are used as feelers (antennæ). There are two pairs of five-jointed legs. The abdomen is greatly elongated and divided into a large number of ring-like segments. On the upper surface of the mite there are two bristles. The abdomen bears two pairs of bristles towards its anterior end, near the posterior end there is also a pair of short bristles, while there are two very long

A BRANCH SHOWING [illegible]

stout hairs at the tail-end with a very small pair between them.

Fig. 2.

The Litchi Mite. Much Enlarged.

Eggs are laid at the base of the hairs forming the velvety pubescence on the under-side of leaves. They are round, whitish in colour and are very large in comparison with the size of the female. The nymphs are similar in appearance to the adults, but are smaller in size and have a lesser number of lateral setæ. They, too, are very active and soon moving briskly along with the adults. A life-cycle probably does not extend more than a fortnight. The mites pass the winter in the adult stage and remain safely ensconced near the base of the hairs on the infested leaves. By the advent of warm weather, about the middle of March, they begin multiplying and spreading to the newly formed leaves where their presence is easily known by the thinner and lighter colour of the velvety pubescence. By the middle of June they reach their maximum development, and at this time the leaves become profusely encrusted with brownish velvety growth, become curled and variously deformed (see Plate XXXIX). In some cases by the coalescence of pits they appear like galls. Later on, by the middle of July, a general dispersal takes place and the upward progress of the mites can be

distinctly traced on the infested trees. The velvety pubescence of leaves of infested trees turns deep chocolate-brown or even black, and the trees present a sickly appearance. This goes on till October when the increase of the mites becomes stationary prior to their resting for the winter. By the middle of November the great majority of them have hidden themselves below the roots of hairs forming the velvety pubescence and remain there till the beginning of March. Thus the mites become torpid with cold from November till March and are then most susceptible to treatment.

The above account gives a brief description of the mite that damages the Litchi (Nephelium litchi) trees which are so extensively grown in Tirhoot and Ranchi in Bihar, and Shahjahanpore and Saharanpore in the United Provinces. The tree is also found to a limited extent in the fruit gardens of Assam, and it is only recently that reports of the damage done by the mite have been received from that Province. The mite has been found exclusively on litchi trees, and no other alternative food plant has yet been discovered. It is mostly distributed from place to place by the importation of grafts from infested localities. To prevent the mite from spreading, it is therefore essential to examine the grafts on arrival and to treat them as recommended below. If, however, only a few leaves on the plants are found affected, these should be removed and the plants carefully sprayed. In a garden the mites are mostly distributed from tree to tree by insects, birds and squirrels, and the fallen leaves when are blown away by the wind.

As already stated above, the best time for treating the trees is the beginning of winter when the trees are dormant and the mites are torpid with cold. But if that time has already passed it is advisable to adopt the following measures after the crop has been gathered in May.

1. Remove all the branches bearing malformed leaves and burn them. In doing so it is essential that the leaves should not be shaken too much or else the mites will fall down on the ground and will again go up the trees.

II. Remove all the fallen leaves below infested trees and burn them. If burning be impracticable, these should be buried in pits and the covering earth thoroughly rammed down.

III. Put either a ring of coal-tar on the stems or dip a long strip of waste cloth in crude oil emulsion and wrap it round the stem.

IV. Spray the trees with crude oil emulsion and flowers of sulphur.

V. Spray the trees once again by the middle of November when the mites are retiring for the winter and before the trees have put forth tender shoots for the season.

At Pusa very good results have been obtained by first removing the infested leaves and branches and then spraying the trees thoroughly with crude oil emulsion and flowers of sulphur. The mite was considerably reduced and the sprayed trees bore fruit well.

To spray take 1 pint (10 chhitaks) of crude oil emulsion, 4 ozs. (2 chhitaks) of flowers of sulphur and 4 gallons (40 lbs. or 20 srs. or a kerosene tin full) of water. The sulphur should first be mixed with ½ pint (5 chhitaks) of emulsion by hand, adding a small quantity of water, if required to make a thick paste; water should then be slowly added and the whole brought up to 4 gallons briskly churning all the while either with a hand force-pump or a knapsack sprayer. The spray-fluid when thoroughly emulsified is then to be put on the trees with a knapsack sprayer, taking care that the underside of leaves is thoroughly wetted and that no part of the tree is left unsprayed. If a few trees in a garden are to be sprayed the knapsack-sprayers will be found both efficient and economical; but where a large number of trees are to be dealt with a spray pump mounted on a cart will be found the most serviceable. The trees should, as far as possible, be sprayed in the afternoon, and only a light dose must be applied at first (*viz.* 4 pint crude oil emulsion, 2 ozs. flowers of sulphur and 4 gallons of water). If, however, this does not remove all the mites, the quantity of sulphur must be doubled, using 1 pint of emulsion, 4 ozs. flowers of sulphur with

4 gallons of water. The sulphur must be thoroughly incorporated with the emulsion by hand, or else it will float on the surface of the spray-fluid. Roll-sulphur, even if ground and sifted very fine, does not serve the purpose as it soon clogs the nozzles of the spraying machines and is not uniformly distributed. To secure satisfactory results flowers of sulphur must be used; this is obtainable from any of the chemists in large towns. In the Mofussil, if crude oil emulsion cannot be obtained, kerosene emulsion prepared as follows should be used instead.

Boil half a pound (4 chhitaks) of sliced Bar-soap in a gallon (5 srs.) of water till dissolved. Take off the fire and add 2 gallons (10 srs.) of kerosene, agitating or beating the mixture till the kerosene is completely emulsified. This is the stock solution. When required for use it is to be mixed with sulphur and used as above. If, however, it be impossible to prepare the kerosene-emulsion, good results will be obtained by spraying the trees with Soft-soap and flowers of sulphur.

Soft-soap	...	...	...	20 lbs.
Sulphur	...	...	...	2 lbs.
Water	...	...	...	60 gallons.

The soap should first be dissolved in 4 gallons of boiling water. The sulphur is then made into a thick paste with water and added to the former, and water added to bring up the whole to 60 gallons.

For calculating the cost of spraying a tree, a row of 7 trees eight to ten years old was separately sprayed with crude oil emulsion and flowers of sulphur. The height of the trees varied from 7 ft. 10 in. to 13 ft. 4 in., and the circumference of the stems varied from 3 ft. 10 in. to 4 ft. 4 in.

		Rs. a. p.
Number of trees 7		
Crude oil emulsion 3 parts : Rs. 6-8 per 40 parts	...	0 7 9
Two coolies @ As. 3 each per day (half day) ...	...	0 3 0
		0 10 9

(Some spray-fluid was left over; and the coolies finished the work in nearly three hours, but for purposes of calculation half a day's wages have been charged for.)

Thus, it will be seen that the cost of spraying a tree comes up to an anna and a half, and this is not much, considering the value of the tree and the crop obtained from it annually. By spraying, not only is the mite checked, but the trees improve in appearance and bear well.

CLIMATIC INFLUENCE UPON THE INCIDENCE OF DISEASE

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The regularity of the appearance of Rinderpest, Foot and Mouth Disease, Haemorrhagic Septicaemia and Blackquarter have caused erroneous ideas as to the importance of climatic influence upon these cattle scourges.

The following remarks are presented with regard to observations made in the Central Provinces.

To take the first named, Rinderpest. Its virulence is greatly enhanced at the beginning of the rains, and the conclusion naturally is that the rains are themselves the cause of it. They are, however, only a very subsidiary predisposing cause. The actual cause of rinderpest and all other contagious diseases, of course, can only be the specific organism, but we know that by long residence of any contagious disease organism in one place, it, in course of time, becomes weakened in virulence to the animals resident in that place. So much so that many of them could act as carriers of the contagion without showing any symptoms, and yet if removed to some distant ground would be capable of giving the disease to animals which had not been in contact with that particular race of organisms. That is, what is known as 'valency' of disease. Such organisms may be comparatively harmless to a herd of cattle, in one area, but may be most virulent if conveyed to cattle the inhabitants of a distant area. It may, therefore, be seen that movements of cattle are the main agents in the outcrops of epidemic disease. Cows, bullocks working bullocks and young stock are grazed in their own

villages and surroundings for the cold and hot weather, and it is possible that rinderpest in latent form is with them all this time; at the beginning of the rains they are marched to a more or less distant jungle for grazing on the young grass which springs up as soon as the rain comes. They there meet cattle from other districts, and each of them in all probability brings rinderpest of a race to which they are immune, but when they come in contact with the strange breed they immediately succumb and may die.

This theory is somewhat discounted by the fact that the serum made at Muktesar is not a multi-valent one, *i.e.*, it is not made from a large number of strains of the disease. In fact, usually only one strain is in use, and yet under ordinary circumstances this serum will immunise Indian cattle throughout India. The susceptibility of cattle or valency of the serum is, however, not always uniform and varies at times in a very marked degree. For instance, there have been extraordinarily good results in Jubbulpore from the use of doses of 5 c.c. of A. R. serum per 500lb. of body weight with 4 c.c. as a minimum, and yet in Damoh, which is only 100 miles away with apparently identical country and cattle, there were a large percentage of deaths after inoculation with the serum. Other instances have occurred in Chanda and Mandla. The latter is probably explainable as Mandla is a plateau of about 2,000 feet, and such cattle may simulate hill animals. Yet even with a few bad results in refractory cattle and in isolated instances, it would appear to mean that the protective dose was not large enough, and not that the serum was ineffectacious. There is also the possibility of its not being of a sufficient multi-valency, but, in the absence of research on these lines, little can be said.

From this it would seem that the valency of rinderpest is to a great extent negligible, but from practical observations it is seen that an old strain of the disease may be harmless to the local cattle, but extremely virulent to those of another district. The seasonal prevalence of rinderpest is therefore not the result of the season but of the movements of cattle.

There is a predisposing fact in that animals during the hot weather or from February until June become very much reduced in condition, partly owing to the debilitating effect of the heat but more to the absence of grazing, and the fact that no artificial feeding is adopted for cows, calves and non-working bullocks. Animals may be seen to get thinner and thinner throughout the dry season. This lowers their resistance, and as soon as the cold and damp of the monsoon commence they are extremely likely to become infected with any contagious disease that is prevalent.

In the case of foot and mouth disease movement of cattle may be seen to be the direct cause of the spread of infection. From the beginning of the rains until the roads become open in October there is very little traffic in grain, timber, cotton, fodder and other produce, and carters' cattle are mostly idle in grass *bits*, etc. As soon as the roads become passable the traffic recommences, and there is a large admixture of animals from widely differing centres at the various roadside camps.

The same thing applies to *Banjaras* and *Ahirs'* herds which commence moving either for fresh grazing or for sale at the various markets. Cattle which have become immune to the local infection of foot and mouth disease are then exposed to different strains of the disease and at once become infected. It is for this reason we note that foot and mouth disease commences in epidemic form in November or December and gradually gets worse until the end of the hot weather when traffic again ceases.

Predisposing causes other than this are that working animals when again taken on the road after comparative idleness are not in hard condition and so more liable to disease. Their feet are soft, the horn becomes thin and the skin round the coronet tender and so more liable to infection. It would also seem that foot and mouth disease prefers the dryness of the atmosphere to the moist condition of the rains.

Another reason for the publicity given to foot and mouth disease amongst working cattle is that although it is seldom fatal and very often only in a mild form, when it attacks working

animals it is the cause of palpable and present loss in rupees, annas and pies. Very little is heard of it amongst young stock and breeding animals, because it does not appear to cause any loss. Animals are ill, ailing and lame for a time, but eventually get well, and unless the owner is grazing cows for ghee-making and there is a loss in milk supply, the damage done is not at the time appreciated. The loss sustained, however, by foot and mouth disease cannot be overestimated amongst young and breeding stock. Pregnant cows lose condition, become poor and thin from being unable to eat, and this has a most deleterious effect upon the unborn calf. Young stock become so weak and poor that very often they never recover from the serious set back they experience. More than once young animals and cows have been found so weak and ill as a result of foot and mouth disease in jungle grazing areas that they were unable to move. It has been shown elsewhere[1] that the monetary loss as affecting working cattle in Berar alone runs into lacs of rupees, and the loss which breeders suffer is incalculable. If does not appeal to the cultivator's mind in this way, he does not seem able to look further ahead than to-day, or to ask himself why it is that many of his calves are born in too sickly a condition to live over any good. For this reason no indigenous attempt is made to suppress or prevent contagion and the staff is totally inefficient to perform any thorough sanitary police work.

Blackleg and Anthrax are mostly more prevalent in the rains, and this is due to the unhealthy conditions of housing. Animals are cooped up for much longer periods in the village kraals, and they stamp about in a horrible slimy mass of mud stirring up the accumulated filth of generations.

Haemorrhagic Septicæmia is most probably carried through the medium of tick bites. It is in the rains that all insect life is most evident, and when ticks are rife is the time we note an increase in the number of Haemorrhagic Septicæmia attacks. This also applies to Piroplasma.

[1] Proceedings of the Agricultural Association, Akola Camp, October 1911.

Surra is the same, and cases are rarely noted till after the advent of the Tabanus and other biting Diptera. The incubation of this disease from ordinary natural infection is somewhat variable, and in any case it is usually some time from the first appearance of the trypanosome that any serious symptoms are noted at least sufficiently serious to be noted by the layman. It therefore follows that we seldom have Surra reported before September.

But here again movement of animals is evident. It is thought that cattle may be reservoirs of Surra, *i.e.*, they may harbour the parasite in their blood, and as they show no symptoms of any disease are a source of danger to equines. Cattle graze throughout the rains in jungle areas where the Tabanus is plentiful. As soon as the Tabanus is numerous, infection is possibly carried freely to many animals by Tabanus bites. Towards the end of the rains the cattle commence their journeys back to work or other grazing areas, and in so doing come in contact with horses then if Tabanus is present we have the appearance of Surra.

It will be seen that although "Seasonal" expresses the appearance of these diseases it is not due actually to seasonal influence, but in the majority of cattle outbreaks to the movements of cattle as a result of trade conditions, transport of crops, grazing necessities, etc. The practical result to be obtained from the above observations is the facility with which methods of prevention can be entertained. A knowledge of the various trade and cattle routes enables one to place a careful watch upon them, and so anticipate epidemics, and by prompt measures of segregation, inoculation, etc., stamp them out. The knowledge that Hæmorrhagic Septicæmia and Blackleg almost invariably attack in the rains allows us to perform preventive inoculation in April and May, and so obviate the risk of reducing an animal's resistance during an actual outbreak. Unfortunately Anthrax cannot be treated by vaccination in this country, as the risk of deaths renders it inadvisable.

There is now very little resistance to the preventive treatment of Rinderpest by the inoculation of serum, because it can be done during the actual outbreaks and immediately its effect is

noticeable. This appeals to the cultivator's mind which is essentially one that will never suggest doing anything to-day that can be put off till to-morrow. A serum may be exhibited in the actual presence of the disease because its action of prevention commences at once and there is no lowering of an animal's resistance as an immediate result. With a vaccine, however, this is not so. A vaccine will produce immunity, but it cannot produce it in less than 4–10 days, and during this interval there is a tendency for the animal's resistance to be lower than if it had not been vaccinated, this of course renders such an animal more liable to infection during that 4–10 days. A vaccine having produced its immunity, the immunity is much more lasting than that produced by serum, it will last for [illegible]–12 months, whereas a serum will not do so for more than [illegible]–6 weeks.

Knowing these facts and the so-called seasonal prevalence of disease again gives us valuable assistance in combating the seasonal recurrence of such diseases as Hæmorrhagic Septicæmia and Blackleg. Active measures are now being taken in the Central Provinces to vaccinate for Hæmorrhagic Septicæmia and Blackleg in April, May and June and so possibly prevent their recurrence in known infected areas during July, August, September and October. It is a system that is not popular with the cultivator. He thinks that as nothing is doing in the way of disease, why bother? Sufficient unto the day is the evil thereof. It is difficult to explain that a vaccination cannot be done during an epidemic. It is hoped that further research in the manufacture of a combined serum and vaccine will in course of time produce a practical result. The writer has already reported on some successful experiments made on these lines.(1) Such a substance would inhibit the period of lessened resistance so that the immune serum would act at once and the vaccine would have its permanent action later.

Preventive vaccination during quiescent periods of the disease necessitates a complete geographical survey of all infected villages

(1) Walker, Serum and Vaccine [illegible] Journal of Tropical Veterinary Science, Vol. VI, No. [illegible], 1911.

and careful cataloguing of such infected areas. Till now very little has been done on these lines owing to want of personnel in the Veterinary Department. This Department is, however, increased numerically and a number of men have been trained in this special work so that active measures will now be taken to carry on efficient preventive vaccination in known diseased areas

SUGARCANE EXPERIMENTS AT THE ALIGARH EXPERIMENT FARM

BY A. E. PARE, M.A., B.Sc. (Edin.),

Deputy Director of Agriculture, United Provinces.

In the United Provinces about 12 lakhs of acres of sugarcane are grown yearly. Of this total approximately ¾ is grown in the Meerut Division and ¼ in the division of Rohilkhand. The Meerut division has an extensive canal irrigation system and almost the whole of its sugarcane is irrigated. Rohilkhand with greater rainfall and restricted canal irrigation grows 40% of its cane on natural moisture.

The crop is sown in March or April usually on land which has been lying fallow for several months, but also in some cases in fields from which a winter crop has just been removed. The "seed" is sometimes cut direct from the standing crop, but frequently it is put in a moist pit for several weeks before sowing. It is sown behind the country plough in furrows about a foot apart. The land is then levelled and afterwards hand hoeings and irrigation are done when required.

Crushing begins about the middle of November and continues to within a short time of the next sowing season. Three-roller iron mills are used as a rule.

The canes grown in the United Provinces for the production of sugar are usually very thin. Thicker canes are grown, but chiefly for chewing. In order to become acquainted with the merits of the canes of the province variety experiments were begun at Aligarh three years ago. The soil on which the experiments have been conducted is clay and is liable to flood for several days in the rains. This excess of water renders the land

useless for "kharif" crops. Cane is well established by the beginning of the monsoon and survives the waterlogging. This piece of lowlying land has been divided into two parts for sugarcane experimental purposes and each plot bears sugarcane in alternate years with a bare fallow in between. It will be necessary to widen this rotation in the near future. The land is always well manured with city refuse and cowdung before sowing.

In 1909 several varieties of cane were collected from different parts of the United Provinces. The best ones were kept on and the poor ones discarded. The collection was added to in 1910 and again in 1911, canes being obtained from other provinces.

Cane in this tract is grown chiefly for *gur*, and the yield of *gur* per acre has been the basis of comparison in the experiments. The juice was pressed out by an iron mill and then boiled in an iron pan.

Up to the present the *desi Saretha* variety has given much higher outturns than any of the others. *Chin* is the local Aligarh variety. The yields of these two varieties are given below. The areas crushed were $\frac{1}{10}$th of an acre in the first year and $\frac{1}{20}$th of an acre in the second.

	1st Year.				2nd Year.			
	Gur. Mds.	Srs.	Ch.	Juice.	Gur. Mds.	Srs.	Ch.	Juice.
Desi Saretha grown from selected cane	164	29	0	1931	101	7	3	12·76
Chin	61	37	8	1149	78	16	6	11·61

The above are exceptionally high yields for the United Provinces. But local cultivators this year reported yields of 80—85 mds. of *gur* per acre from *desi Saretha*.

Cultivators near the Farm have taken considerable interest in the *Saretha* cane since the experiments first began. Last year a few acres were grown in the villages. A large part of the produce was kept for seed this year with the result that there are now about 200 acres under *Saretha* in this tract. The

area should increase very rapidly during the next two years. The cane has also been well reported on from Moradabad district where it is being grown for the second year on an increased area. Indents for *Saretha* cane were received from a large number of districts of the United Provinces and also from Bengal, so that this year its value under very varied conditions will be tested. A small consignment was also sent to America, but truth compels me to state that the gentleman who asked for it was on the look out for fodder plants and not for sugar producers. *Desi Saretha* is a very tall, reddish cane, and is grown extensively in Muzaffarnagar district. It is peculiar in that it flowers very frequently. In fact, it has flowers every year at the Aligarh Farm. On this account many cultivators did not look upon it with favour at first as they said that flowering results in much less *gur* being produced and also in general deterioration of the next year's crop if grown from flowered cane. Several experiments have been carried on to test these theories.

In 1910 flowered *Saretha* canes were selected and sown in a plot of 1·30th acre and an exactly similar plot alongside non-flowered canes were sown. From these two plots *gur* was made. The outturns were as below

	Mds.	Srs.	Chs.	
Flowered *Saretha*	111	36	4	12·5%
Non-flowered *Saretha*	111	7	4	12·5%

The difference is only about 1% and no definite conclusion can be drawn in favour of the flowered cane. At the same time it may be pointed out that only the best developed canes flowered, and selection of the flowered canes was merely another way of picking out the thickest and tallest canes.

In addition to the above experiments during 1910-11 and 1911-12 several comparative crushings of flowered and non-flowered *Saretha* canes were made. The table below gives the detailed results.

Date of crushing.	Flowered.						Non flowered.					
	Weight of canes crushed.			Weight of gur obtained.			Weight of canes crushed.			Weight of gur obtained.		
	Mds.	Srs.	Ch.	Mds.	Srs.	Ch.	Mds.	Srs.	Ch.	Mds.	Srs.	Ch.
6—12—1910	—			—			4	—	0	0	17	0
17—12—1910	1	0	0	0	21	8						
8—8—1911	2	14	0	0	32	5	2	14	0	0	32	8
7—8—1911	1	0	0	0	18	7	1	0	0	0	17	10
17—1—1912	1	32	8	0	7	13½	1	32	8	0	7	10
18—1—1912	1	20	8	0	0	0	1	20	8	0	0	8

In the case of the crushings made on 7-8-11 and 8-8-11 the canes had flowered about two months previously. No reduction in the quantity of *gur* was noticeable even after that length of time. The quality of *gur* made from the flowered canes was in no way inferior to that from the non flowered canes.

The above-mentioned experiments seem to indicate that in the case of *Saccha* no appreciable loss of *gur* results from the flowering of the canes.

In 1910 variety experiments were begun with canes suitable for chewing purposes. Some Mauritius canes proved much superior to the local varieties right from the first. They have given greater yields per acre and have not up to the present been so liable to the attacks of white ants. Last season a few plots were grown in the villages near the Farm. The year was a bad one for cane on account of the late rains. In some cases the local chewing canes were destroyed by white ants, whilst Mauritius cane on neighbouring plots produced a good crop.

As a result of these demonstrations there was a large demand for Mauritius cane at sowing time this year. The area will probably increase quickly until the local varieties are supplanted.

NOTES.

SUGAR-CANE IN JESSORE.—Sugar-cane in Jessore is not a common crop. This district is the centre of the extensive date-palm-sugar industry, and the people prefer the peculiar taste of sugar made from the date to that from the cane. Moreover, the growth of sugar cane is rather precarious as much of the district is low lying and subject to floods. The wild date-palm, (*Phœnix sylvestris*) offers the advantages that no matter what the climatic conditions may be, its yield is certain and it requires very little cultivation. Where cane is grown, however, in the district good yields seem to be obtained.

During a tour of investigation of the date-sugar industry the writer had an opportunity of making some measurements and analyses of the cane from a particular field in village Gobardanga, 3 miles east of Kotchandpur.

Area.—In the village there are about 10 *bighas* of cane, one *bighá* being equivalent to $\frac{1}{3}$ acre.

Variety.—*Kuchi*, a purple cane, is practically the only variety grown. A few white canes appear here and there among the *kuchi*.

Soil.—This varies from loam to clay.

Cultivation.—This appears to be very badly done, the surface of the fields consisting of huge clods of earth.

Sowing.—This takes place in March, when the land receives its only irrigation. Only the tops of the cane are sown: these all being carefully removed from the cane before crushing. Each top makes two sets, each set having one complete internode

and two complete nodes. Each set is put in the ground with the buds in the lateral position.

Manure.—Cowdung is generally applied at the rate of 15—20 loads (of about 6 maunds each) per bigha.

Earthing up.—This is carried out about 4 months after sowing when the cane begins to fall down.

Binding canes.—As they grow to about 3 ft. in height the canes of each stool are bound together.

Cropping.—This begins about the end of January and continues till the end of February.

The mills used for the purpose are very good 3 roller mills. The cultivators hire these at Re. 1 per day which seems a very high rate.

Boiling.—This does not begin till late afternoon. The juice is collected in earthen pots and stored in these open pans under a thatched roof till 3 or 4 o'clock in the afternoon. The cultivators informed me that this is done in order to give the impurities, the easy time to rise, time for diving. The boiling is carried out in earthen open pans of Co 419 type. These are scrupulously cleaned daily by scouring with water. In those places where sugar-cane is grown in dessi soil, iron pans are used for boiling the juice and these pans are only about 3 inches in diameter and about 10 inches deep. They are also lined. In order to clarify the juice small amounts of milk and mustard are added from time to time during the boiling.

Marketing.—The gur made is of excellent quality; it has a lovely golden yellow colour and is an eating gur. It is exported to larger towns to the west and north such as Santipore, etc. Last February was selling at Rs. 4 per maund (pucca).

Diseases, etc.—A considerable amount of red rot was noticed in the canes. Apparently the cultivators did not use sowing diseased canes. The importance of not sowing diseased cane was impressed upon them. White ants also give a certain amount of trouble.

Yield.—The writer was told that about 20 pucca maunds of *gur* per bigha (of [illegible] acre) was the usual yield, but that 30 maunds was occasionally obtained. An area 16′ × 25′ in the cane field was measured out. The average distance between the rows was 2′ 8″ and on this area there were 117 stools, 52 of the stools contained 136 canes, that is, an average of 3 canes per stool, a total of 351 canes in the area. The number of canes in a stool varied from 1 to [illegible]. [illegible] stripped canes were found to weigh 15 lbs. 8 ozs., an average of 0·91 lb. per cane. So that the total weight of stripped cane in this area was 319 lbs. 5 ozs. This comes out at [illegible] tons per acre of stripped cane.

Amount of juice extracted.—Two tests were carried out in order to determine the percentage of juice extracted from the cane by the hired mills.

I. [illegible] lbs. 11 ozs. of cane yielded [illegible] lbs. 4 ozs. of juice or 66 per cent. Time 2[illegible] minutes.

II. [illegible] lbs. of cane yielded [illegible] lbs. [illegible] ozs. of juice or 66 per cent.

Each [illegible] parts of juice gave [illegible] of *gur*, so that the yield of *gur* per acre works out [illegible] 2·2 tons.

Composition of [illegible].—Analyses of the juice were carried out on [illegible] days.

1 [illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	0·48
[illegible]	[illegible]	[illegible]	[illegible]

The sample marked 1 was the juice expressed from a single cane. It had been picked up at random and crushed at the [illegible] Laboratory and analysed. The other three juices were from three different boiling [illegible].

Composition of [illegible].

Sucrose	67·08
[illegible]	[illegible]
Invert sugar	[illegible]

It might be noted here that *Kozhi* cane is described by Mollison and Leather in Agricultural Ledger No. 8 of 1898 at page 60. The following figures are there given for it

Juice ...	...	...	86·0
Sugar in juice ...	...	...	17·05
Glucose in juice ...	...	...	1·51
Specific gravity at 15·5°		...	1·083

(H. E. ANNETT)

* * *

EXTRAORDINARY GROWTH OF CANE. The photo opposite depicts a striped Mauritius cane taken from a cane field at Katravulapalle, some eight miles from Samalkota, during a recent tour made by the third year students of this College. The size of the cane may be judged from the white spots on the bamboo to which it is tied. It was in all 20 feet long, about 23 feet of this was solid cane, the remaining 6 feet being top. Though this is, of course, an exceptionally good specimen, the field from which it was taken was a wonderful sight as it must have averaged over 20 feet in height. The soil was a perfect alluvial loam with enough sand in it to keep it open and exceptionally deep. Castor cake, which is the accepted manure for this crop in this district, had been applied while the canes were about $\frac{1}{2}$ months old at the rate of 1,600 lbs. per acre.—(R. W. B. C. Wood).

VARIOUS methods of forcing plants to induce early growth after the winter rest have recently been tried with success. Perhaps the simplest is the immersion of the plant for certain hours in warm water. As it appeared that this might be a useful method of accelerating the growth of sugarcane setts which are subject to the depredation of white ants in the interval between planting and active growth, an experiment was tried. A number of setts were divided into 3 lots, one consisting of half the setts was untreated, the second was immersed for 7 hours and the third for ten hours in water

PLATE XL.

at a temperature of 102° to 104° Fahrenheit. Of the latter, three setts were immersed in a bottle containing a 20 per cent. sugar solution—a fruit preserving apparatus being used for the immersion.(1)

The setts were all planted in somewhat dry garden soil on January 28th and were not irrigated. On February 20th, 8 of the forced setts had shoots above ground and only 2 of the unforced setts. On March 14th all the setts were dug up. With the exception of the setts immersed in sugar solution, which were absolutely eaten by white ants only the shell being left, all the forced setts that had good eyes had shoots about eight inches high above ground, those with bad eyes had made roots but no shoots; there was no general difference between those immersed for 7 and 10 hours respectively. Of the unforced setts also, all those with good eyes had sprouted and the rest had made roots, but only the two shoots above referred to had appeared above ground and they were only about four inches high. The result of the treatment was therefore to accelerate sprouting considerably, the forced setts being about three weeks ahead of the unforced, and more vigorous. The date of planting was somewhat early, and no doubt the difference would have been less marked if the setts had been planted later and in moister soil. Another experiment in which the temperature ran up to 116° F. in the first half hour and was then reduced to 110° at which it remained for 6 hours showed that the setts were not killed by this treatment, although germination was somewhat slow and irregular.

It was found that a closed tin vessel of water placed in a sheltered corner in the sun maintained a temperature of 104° at the end of January and 110° in the middle of March from 11 A.M. till [illegible] P.M. at Pusa (lat. 26°). There would not therefore be any great difficulty in maintaining a large covered tank at this temperature for six or seven hours. This method of forcing

(1) It was [illegible] because of the large percentage [illegible] setts [illegible] taken from [illegible] lower [illegible]

might be tried on potatoes which sometimes require an extravagant amount of irrigation after planting before they will sprout, in India.—A. C. DOBBS.

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WE have been favoured with a copy of the paper on a plea for the education of the agriculturist submitted by Sirdar Bahadur Sardar Dyal Singh Majithia, President of the Council of Regency, Faridkot State, to the Sikh Educational Conference recently held at Sialkot. In it we notice that there are in the villages of that State bodies called the Neki Pracharak Committees, composed of all the leading men of the villages. Their most important duties are stated to be the promotion of education and sanitation amongst the cultivators. It is reported that they have worked so successfully that demands for more village schools and hospitals are being put forward and people even offer to contribute a share of their cost. The President of the Council has prepared in Punjabee a series of courses for the village schools, which besides imparting education in the three R's are intended to give children some instruction in their future every-day avocation. He has also got at Faridkot a paying model farm and farmer's house which serves as an object lesson to agriculturists.—(EDITOR.)

REVIEWS.

EXPERIMENTS ON PADDY CULTIVATION DURING THE YEARS 1909-11. By LESLIE C. COLEMAN AND D. G. RAMCHANDRA RAO. BULLETIN NO. 2, GENERAL SERIES. DEPARTMENT OF AGRICULTURE, MYSORE STATE. PRICE 0-8-0.

IN this Bulletin the authors detail and summarise the results of experiments on paddy, planned for the most part by Dr. Lehmann previous to his retirement in 1908, and which have been since carried out on the land tested and designated by him for the purpose. Although the period has been so short, the system adopted of testing the plots, and the considerable differences obtained in the yields of the plots variously treated, justify the deductions made by the authors and their publication. Of the results obtained, the most important is probably that which definitely establishes that at least under certain conditions the ploughing of the land in puddle immediately before transplanting paddy results in a larger yield of grain than ploughing immediately after the previous harvest. This fact is well known to cultivators in South Behar and we have ourselves observed the bad effects of disregarding it on the heavy black paddy soils of that region. In discussing the factors that may possibly contribute to this result, the authors dismiss as inappreciable, for good reasons given, the effect of the greater growth of weeds on the unploughed plot acting as a green manure on the one hand and of the greater decomposition of humus due to early ploughing in the other. Proceeding to discuss a suggestion that early ploughing might result in greater solubility of soil constituents which might thus be leached out by flooding, the authors show that, in fact, the greater solubility was found in the unploughed plots. This they

say is contrary to expectation; but we venture to suggest that to anyone who has closely observed the effect of desiccation of heavy unploughed paddy land, like that in South Behar, causing numerous cracks three or four inches wide, one or two feet apart, and of similar depth; and who has also noticed the effect of the first shower of rain on such desiccated land—which is exactly like the effect of a thaw on frozen clay—it is clear that physical changes of considerable significance must take place as a result of desiccation. Early ploughing, by conserving the moisture, must inhibit these changes, and it is quite possible that it is exactly the greater solubility of some of the soil's constituents, or the destruction of its colloidal properties, resulting from desiccation, and consequent aeration to a great depth, that is of benefit to the succeeding paddy crop. The authors finally suggest that one of the chief factors concerned may be the alteration in the bacterial content of the soil. Having regard to the important rôle played by bacteria in many cases where physical changes produce a chemical result, this is exceedingly probable, and the differentiation of the result with respect to the variables that function in the process is likely to be a very pretty problem. Meanwhile, it would be interesting to try the effect of the puddling of, say, black cotton soil, and subsequent thorough desiccation, as against ploughing, as a preparation for other crops; the common rotation of sugarcane with paddy, referred to in this Bulletin, provides a precedent that might be worth following up.

Another conclusion drawn from these experiments is that saltpetre produces no decided increase in the yield of paddy. Taking also into consideration the experiments in Japan and Hawaii referred to in the Bulletin, it would appear probable that the results obtained with saltpetre on paddy elsewhere in India are not essentially due to the saltpetre.

The Japanese salt-water method of selecting paddy seed of high specific gravity was also the subject of experiments here described, and, in the authors' words, "appears to be a practical method for bringing about a decided increase in the yield . . . . . at very slight expense." The method consists in

sowing only those grains which sink in a solution of one part by weight of salt in two of water.

The Bulletin exhibits the wide views and the grasp of essentials that we have learned to expect of Dr. Coleman.—(A. C. D.)

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RURAL ECONOMY IN THE BOMBAY DECCAN BY G. F. KEATINGE, I.C.S. PRICE 4 SHILLINGS, 6 PENCE; PUBLISHED BY LONGMANS, GREEN & CO.

INDIA being essentially an agricultural country, its rural economy must always remain a question of absorbing interest. We, therefore, welcome Mr Keatinge's book on Rural Economy in the Bombay Deccan which is a very important contribution to our knowledge of village economies in that part of the Bombay Presidency. When Mr Keatinge contributed a series of articles to this Journal in 1910-11 on this subject, it had occurred to us that it would be a good thing if the author could find time to amplify them and bring them out in book form. We are glad that our desire has been fulfilled. The whole book, from beginning to end, is very interesting reading, written as it is in an attractive style. The reader will not fail to mark the author's broad outlook and intense sympathy with the cultivator evidenced in its pages.

In the chapter on Land Tenures in the Deccan, we read with pleasure that it is a special feature of the Bombay system that a guarantee is given against any increase of assessment due to improvements effected by the cultivator. The effects of this system cannot but be beneficial as it gives an interest to the cultivator to invest his capital in digging wells, clearing up deep-rooted weeds, making embankments, etc. In the chapter on Distribution and Nature of Land, the author touches upon the root cause of the cultivator's poverty and points out that it is mostly due to his very small and scattered holding. He defines an economic holding, suggests what it might be with reference to the local conditions, and briefly describes the action taken in Sweden, Austria, and Italy to bring about this desirable result.

The chapters on the efforts made in that part to put the cultivator's credit on a better footing are instructive. In view of the agitation recently set on foot to prohibit the slaughter of animals in this country we would draw the attention of the readers to Mr. Keatinge's discussion over the statement so often made that the slaughter of cattle is, in a great measure, responsible for the deficiency of cattle. He shows that the animals slaughtered are generally barren cows or useless and malformed cattle unable to do any field work, and points out that over and above those slaughtered, there are thousands of useless cattle kept alive which could better be disposed of, thus making more fodder available for work-cattle and the young stock. In connection with the question of the growing substitution of non-food crops, particularly cotton and oil seeds, and the high prices now ruling for food grains, Mr. Keatinge shows that this has been due to the opening of the European market, the steady development of internal trade, and a perception on the part of cultivators as to what pays them best to grow.

Part V of the book deals with State aid to agriculture: the first chapter on the limits of Government action is very instructive and illuminating, and in it we would particularly refer to the author's treatment of the question of *gur* and sugar manufacture. The book closes with a brief resume of the work of the local Agricultural Department.—(Editor.)

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THE MANGO BY P. J. WESTER. BULLETIN NO. 18 OF THE GOVERNMENT OF THE PHILIPPINE ISLANDS, DEPARTMENT OF PUBLIC INSTRUCTION, BUREAU OF AGRICULTURE.

This contains a full account of the botany and cultivation of the mango in the Philippine Islands, together with some interesting remarks on the nomenclature and geographical distribution of the species. The mango appears to have been introduced into the Philippines in the latter half of the seventeenth century. Earlier references to the fruit evidently refer to the two native species of Mangifera, fruits very inferior in quality to the mango

of India. At present mango cultivation in the Philippines is in its infancy. Trees are planted along the edge of rice fields or in any situation where the ground is considered too poor to be worth cultivating. Notwithstanding this they appear to thrive amazingly, but there can be no doubt that with improved methods of cultivation the yield could be greatly increased. There are three principal varieties, all of which ripen their fruit between May and July. By smoking the trees and chopping the bark of the trunk the Filipinos force them to bear fruit as early as March. This early fruit, however, is inferior to that produced later in the year. The Philippine mango, although one of the most flavoured in existence, has a very short vegetative season, while the exterior of the fruit is lacking in attractiveness and the seed is proportionally larger than in some Indian varieties. By the introduction of several of the varieties grown here the mango season in the Philippines might be prolonged until late in October.

A particularly useful chapter is that on "Propagation." The mango is always grown as a seedling in the Philippines, with the result that many of the trees produce only a small tithe of fruit compared to what they should do if grown on separate stocks. Instructions are given for budding, grafting and inarching and also for topworking, a method of restoring productivity to old trees which might be tried with advantage in many parts of India such as Malda where sterility is common.

The mango appears to grow well on almost any soil. It requires considerable space for the development of its root system, the distance recommended for planting in the Philippines is 10 meters between each tree, which is considerably more than that advocated by some Indian writers.

With the exception of damping off and mildew, which attack young plants in the nursery, the mango in the Philippines is remarkably free from fungus diseases. The mango blight fungus (Colletotrichum gloeosporioides), which, under certain conditions, is very destructive in Florida, does not occur here. This disease, however, is easily controlled by Bordeaux mixture,

while the damping off and mildew can both be prevented by keeping the seedlings under drier conditions.

Insect pests appear to be more serious than diseases due to fungi. Fumigation with cyanide of potassium and spraying with whale oil soap or kerosene oil are the methods recommended for dealing with these troubles. The bulletin concludes with a series of formulæ for fungicides and insecticides, and a set of computation tables which should prove useful to the practical grower in India and elsewhere. (F. J. F. S.)

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